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Vol. xxii JUNE, 1917 No. 6

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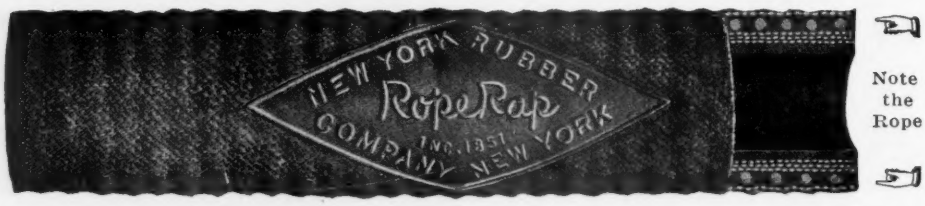

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Vol. xxii. JUNE, 1917 No. 6.

THE COMPRESSORS THAT WERE SCRAPPED.

SAVING BY SCRAPPING AIR COMPRESSORS

BY STEPHEN W. SYMONS

It would be difficult to find a more striking illustration of the economies that can be effected by the substitution of modern equipment for old than that offered by the Pennsylvania Coal Co., at its No. 6 colliery near Pittston, Pennsylvania.

In this plant the company had a battery of seven straight-line, simple-engine-driven, three-stage air compressors for charging haulage locomotives. Each machine had air cylinders of 11½-in., 9-in. and 4½-in. in diameter, with a common 20-in. stroke. At a speed of 250 r.p.m., these machines had a piston displacement of 600 cu. ft. of free air per minute each, or a total piston displacement of 4,200 cubic feet.

The air-haulage system having been discarded, the air from these compressors was turned into the main pipe line, supplying hoisting engines, drills, etc., its pressure being reduced to 100 lb. by means of a Foster reducing valve. Besides the high-pressure machines, there were two straight-line, single-stage compressors supplying air at 80 lb. to another portion of the mine. These machines had air

cylinders 26¼ in. in diameter, steam cylinders 22 in. in diameter, with a stroke of 30 in., and a total piston displacement of about 2,800 cu. ft. per minute, making the capacity of the entire plant, on the basis of piston displacement, 7,000 cu. ft. per minute.

The three-stage machines had been installed some 10 or 12 years ago and, after the change from high- to low-pressure service, it did not take the operating company long to realize that the plant was decidedly inefficient and so costly in operation as to warrant installing more economical and up-to-date machines.

After the usual period of investigation, it was decided to install an Ingersoll-Rogler corliss-engine-driven compressor, with two-stage air cylinders of 29- and 18½-in. diameter respectively, and compound steam cylinders of 23- and 21-in. diameter, having a 24-in. stroke and a piston displacement of 2,550 cu. ft. per minute, and discard the seven three-stage, straight-line machines. A new system of pipe lines, which eliminated restricted orifices, leakage, etc., was also installed, to take the place of both former systems.

After the new compressor was started up, it was found to be unnecessary to continue the operation of the two low-pressure machines, as the new compressor would take care of the entire mine. The effect on the steam consumption of the plant was extraordinary. No exact figures are available, but a fairly accurate estimate can be made of the consumption of the different machines, from which the total saving can be approximated.

It is safe to say that the steam consumption of the seven three-stage machines, when operating at the high speeds mentioned, would total 44,000 lb. per hour; the loss in reducing the air to the working pressure of 100 lb. being considered. The two single-stage machines, when operating at their rated capacity, would require 504 i.hp., which, based on a steam consumption of 40 lb. per i.hp.-hr., would require the evaporation of 20,000 lb. of water, making a grand total of 64,000 lb. of steam per hour for the entire compressed-air plant.

The new compressor, which is operating noncondensing, has a steam consumption of about 21 lb. per i.hp.-hr. and, when developing its normal load of 400 hp., would require 8,400 lb of steam per hour. Assuming that 1 lb. of coal would evaporate 5 lb. of water, it would require 12,800 lb. of coal per hour to operate the old plant and only 1,680 lb. per hour for the new, thus making a saving of 11,120 lb. of coal per hour.

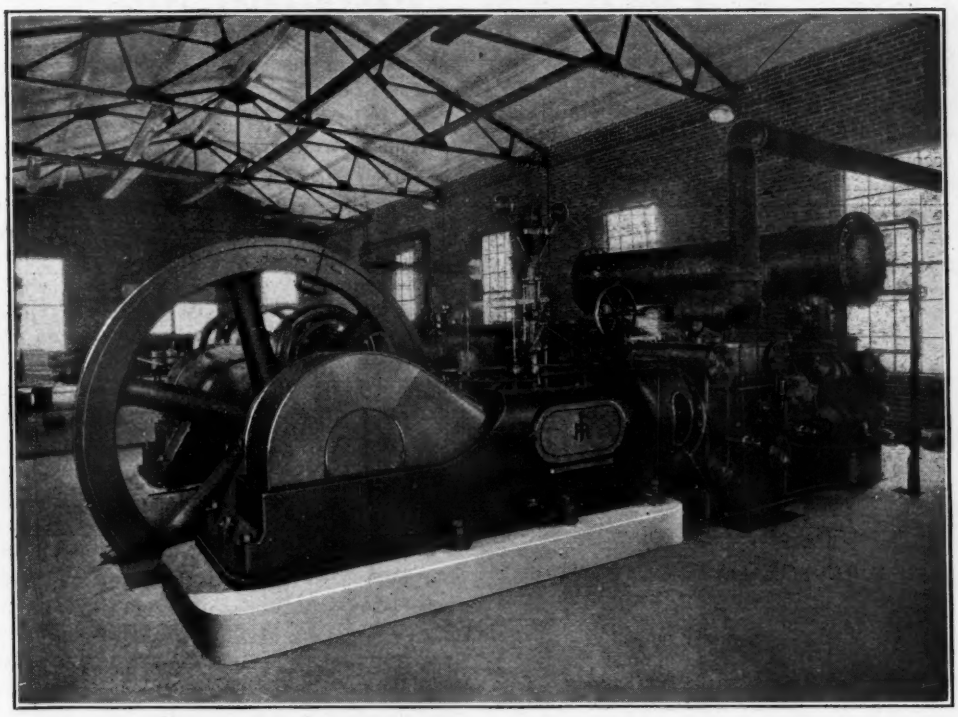
On a basis of cost this would amount to 55.6 short tons per 10-hour day, or 16,680 tons per year of 300 working days, which, with coal at 50c. per ton, would represent a saving of $8,340 per year. At this rate, assuming that the compressor cost $15,000 installed, it would take but two years to pay off its entire first cost.

The saving in water was, of course, 64,000 —8,400 = 55,600 lb. Another remarkable saving, due largely to the refinements in the design of the new machine, was realized in the reduced consumption of lubricating oil, both for the cylinders and running gear. Both steam and air cylinders of the new machine are lubricated by force feed, this alone resulting in a reduction in the amount of oil required besides providing more perfect lubrication. Add to this the fact that, in the old plant, there were no less than 23 air cylinders and nine steam cylinders to feed, against two steam and two air cylinders in the new plant, and the saving is apparent.

More striking still is the reduction in the oil required by the running gear. The old machines were all of the twin-flywheel, outside-crank type, with the entire running gear lubricated by means of oil cups, while the new machine is of the wholly inclosed type, with the running gear lubricated by an automatic flood system, which only requires a small quantity of oil to be added every month to that already contained in the system.

A rough estimate of the saving in lubricant can be made as follows: Experience has shown that a 24-in. stroke compressor with flood lubrication requires about 15 gal. of oil per month, added to that contained in the reservoir in the main frame or crank case, to make up for losses. This amounts to about 180 gal. per year of 300 working days and, with oil at 25c. per gallon, would represent a cost of $45 per year.

The seven 20-in. and two 30-in. stroke straight-line compressors with oil-cup lubrication would be provided with oil cups on the main bearings and eccentrics, for crank and crosshead pins, piston rods and guides, at least twelve cups being provided for each machine, or 108 cups in all, having an average capacity of ¼ pint each. These cups would have to



ONE COMPRESSOR MORE THAN ENOUGH.

be filled on an average three times a day or, roughly 1 gal. of oil per machine per day, a total oil consumption of 9 gal. per day, or 2,700 gal. per year of 300 working days, representing a cost of $675. The saving, to the credit of the new machine, would be $630, even more remarkable in its way than that realized on fuel and water. The greater cleanliness of the new machine is also marked.

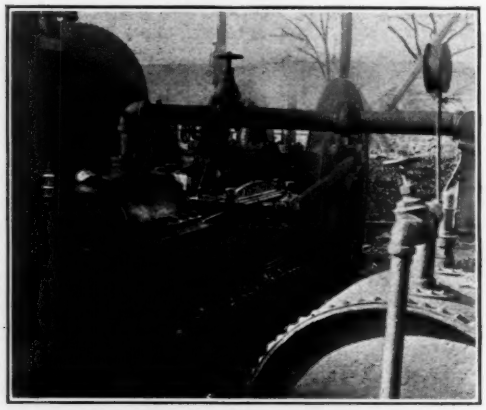
The saving on attendance was equally noticeable, to say nothing of the saving in handling coal and ashes, maintenance and attendance on boilers, of which several were shut down, saving on buildings due to the smaller floor space, etc. A statement of repair cost, of course, cannot as yet be given, but it will obviously be less for a single machine, new and of modern design, than for nine old machines that had about reached their limit of usefulness.

Of course, the credit for this remarkable performance is by no means entirely due to the higher efficiency of the new machine, but arises chiefly from the fact that the rated capacity of the old plant was more than twice as much as was actually required; and this in turn is accounted for, first by the method of basing these capacities on piston displacement, which is a misleading term, and secondly on the condition of the original pipe line, which was not properly designed and showed some leakage. The original plant was of such old design, and the machines were operating so much over speed, that while they were producing more than their rated capacity at normal speed, this was but little more than 50 per cent. of their piston displacement at the increased speed.

The question of the design of pipe lines is one that has been generally neglected. There is no reason why a properly installed pipe line should show any appreciable leakage and, when designed with due reference to the capacity of the plant and terminal pressure required, the loss due to friction should be a negligible quantity.

There are many other plants, in the coal districts, where similar changes could be made with profit—plants where practically obsolete equipment has been nursed and coddled along

by the mine operators for years, with the idea that, because fuel at the mine is cheap, they can afford to operate extravagant machines. But fuel cost is by no means the only cost; maintenance, depreciation, attendance, boilers, coal- and ash-handling, etc., all enter into the account.



A COMPRESSOR SURVIVOR

A COMPRESSOR IN SERVICE THIRTY YEARS OLD

BY H. L. HICKS

Contractors, especially small ones, often employ machinery that has outlived what might be counted a reasonable period of usefulness, an apt illustration of which is presented in the little photo reproduced on this page. The shop number (264) of the compressor here seen identifies it as having been built in 1887 in the New York City shops of the Ingersoll Rock Drill Company. The air and steam cylinders are 10 in. diameter and 18 in. stroke. One striking feature is the absence of a water jacket. The air in the cylinder is cooled by a spray of water pumped into the cylinder with each stroke. This early arrangement is less effective than even the insufficient water-jacketing of the machines which immediately followed and is not to be compared with the devices of the present day. This compressor was built for the Hackensack Water Co. for aerating water, and was in continuous use for ten years; then, after a period of idleness, it passed into the hands of contractors and was employed on various jobs. It is now operating rock drills on a foundation excavation, giving continuous service with scant attention.

OVERWHELMING DISASTER TO ALASKA-TREADWELL MINES

A most unusual disaster has apparently put an end to the great Alaska Treadwell mine on Douglas Island, Alaska. It seems unlikely that any engineering scheme can recover it from the grasp of the sea, which a week ago burst through the narrow barrier of rock formerly protecting the mine and flooded the historic workings. Reports from Juneau indicate that the loss is irrevocable, as one might indeed suppose from a bare statement of the facts. The mine has become, one might say, an arm of the sea, and with the subsequent dashing of the waters, the condition will only become worse. The Alaska-Treadwell has been worked to great depth below sea level, and it would probably require years, if such an attempt were within the pale of wisdom, to open working chambers below in such manner as to avoid a further inpouring of the ocean. Only at an enormous cost, if at all, could the property be made to again yield a profit from the extremely low grade of gold ore which has hitherto been made to earn dividends. The Treadwell ores have run between $2 and $3 a ton, and only through a policy of handling immense tonnages, subject to treatment in a great amalgamation and cyaniding mill, has the mine been made to pay. Such immense tonnages can probaly never be handled again by any means which capital would be willing to risk. This remarkable mine was opened thirty-five years ago and has earned many millions of dollars. The Alaska Treadwell company, which was recently consolidated with other companies, paid to its stockholders more than $15,000,000. The mine lies about two miles southeast of Juneau, upon the edge of Gastineau channel, the waters of which have now taken possession of the workings. The values occur in a huge dike, 450 feet in thickness, which cuts through the altered slate country. The dike itself is filled with numerous small seams in which the gold occurs with pyrite. Other properties upon the same dike are still working, and will continue to work. It is hard to realize that the famous Treadwell is a thing of the past, the end has come with such startling suddenness. It has been a proverb of low mining and milling costs for prospectus writers of the last twenty-five years. —*Mining American.*

TABLE I.

Cost Of Coal At One Dollar Per Ton To Compress And Deliver 100 Cu. Ft. of Free Air

(Multiply figures in table by price of coal in dollars per ton) Ton = 2000 lb.

Weight of Steam - In Pounds - Required by the Engine - Per Horsepower per Hour.										
	24	26	28	30	32	34	36	38	40	42
Weight of Coal - In Pounds - Per Horsepower Per Hour - When Boiler Is Evaporating 7 lb. of Water Per Pound Of Coal.										
	3.43	3.714	4.	4.286	4.571	4.757	5.143	5.428	5.714	6.
Brake H.P. to deliver 100 cu.ft. free air per minute	Cost of Coal Per H.P. Hour At One Dollar Per Ton - -Fractions of Cent-									
	.1715	.1857	.2	.2143	.2285	.2378	.2571	.2714	.2857	.3
	Cost Of Coal Per 100 Cubic Feet Free Air - -Fractions of Cent-									
16	.0457	.0495	.0533	.0572	.0610	.0634	.0686	.0724	.0762	.08
18	.0514	.0557	.06	.0643	.0686	.0714	.0772	.0814	.0857	.09
20	.057	.0619	.0667	.0714	.0762	.0793	.0857	.0904	.0952	.10
22	.0627	.0681	.0733	.0785	.0838	.0872	.0943	.0995	.1047	.11
24	.0684	.0743	.08	.0857	.0914	.0951	.1029	.1085	.1142	.12
26	.0741	.0805	.0866	.0929	.099	.103	.1114	.1175	.1238	.13
28	.0798	.0867	.0933	.10	.1066	.1109	.12	.1266	.1334	.14
30	.0855	.0929	.10	.1071	.1142	.1189	.1285	.1357	.1429	.15

Example - If it requires 22 brake horsepower to deliver 100 cubic feet of free air per minute at 90 lb. pressure, and the compressor is driven by an ordinary steam engine requiring 34 lb. of steam per horsepower hour, and an ordinary boiler evaporating 7 lb. of water per pound of coal, and with coal at $6 a ton - the coal cost per 100 cubic feet of free air is .0872 x 6 = .5232 cent.

H. V. Conrad.

COST OF COMPRESSING AIR BY DIFFERENT DRIVES

BY H. V. CONRAD

In considering the purchasing of a relatively small air compressor unit, say 50 to 100 horse power capacity, it is often desirable to consider various sources of power for operating it and the cost of fuel. Data given in the Practical Reference Tables have been compiled to show readily these comparisons wherein the air compressor is to be driven either by:

I. Steam Engine, direct connected or belt driven.

II. Gasoline Engine, direct connected or belt driven.

III. Electric motor, direct connected or belt driven.

It may be noted from the example given in each table that to compress and deliver 100 cu. ft. of free air at 90 lb. pressure,

I. The cost of coal will be.. 0.5232 cent

II. The cost of gasoline will be ..... 1.08 cents

III. The cost of electric current will be ..... 1.1 cents

when the cost of coal is taken at $6 per ton, gasoline at 22c per gallon, and electric current furnished by a steam operated commercial distributing plant at 4c per kilowatt-hour.

In using these tables it is, of course, necessary to assume certain figures suiting local conditions in order to make proper comparisons, after first determining the horsepower required to compress and deliver 100 cu. ft. of free air per minute and assuming the mechanical efficiency of all the machines is about the same:

In Table I, the steam consumption of the engine must be approximately determined. In the example, it is taken at 34 lb. per horsepower per hour; if it were 17 lb., the cost of coal would be ½. The boiler evaporation in the table is given as delivering to the engine 7 lb. of water for each pound of coal burned, and any percentage of variation from this performance should appear in the calculations.

TABLE II.

Cost Of Gasoline In Cents To Compress And Deliver 100 Cubic Feet Of Free Air.

Gasoline Consumption One Pint Per Brake Horsepower Per Hour

Brake Horsepower to Deliver 100 Cubic Feet Free Air Per Minute	Price of Gasoline Per Gallon -Cents-							
	8	9	10	11	12	13	14	15
16	.266	.300	.333	.366	.400	.433	.466	.500
18	.300	.337	.375	.413	.450	.487	.525	.562
20	.333	.375	.416	.458	.500	.542	.584	.626
22	.366	.412	.458	.504	.550	.595	.642	.687
24	.400	.450	.500	.550	.600	.650	.700	.750
26	.433	.488	.542	.596	.650	.705	.759	.813
28	.466	.525	.583	.642	.700	.758	.816	.875
30	.500	.563	.625	.688	.750	.813	.875	.938

Example:- If it requires 22 Brake Horsepower to deliver 100 cubic feet of free air per minute at 90 lb. pressure, and gasoline at 22 cents per gallon, the gasoline cost per 100 cubic feet of free air is .504 x 2 = 1.08 cents.

H. V. Conrad.

When the final figure of cost in the table is determined, it must be multiplied by the cost of coal in dollars per ton. A steam driven compressor requires boiler power, and the cost of this and the expense of operating it must be considered, when comparing with other sources of power, aside from the cost of coal, which latter is covered by the table.

In Table II, the gasoline consumption per brake horsepower will not vary greatly, but the percentage of variation should be considered. If kerosene or other oils are burned

TABLE III.

Cost Of Electric Current In Cents To Compress And Deliver 100 Cubic Feet Of Free Air

Brake Hp. To Deliver 100 Cu. Ft. Free Air Per Minute	Price Of Electric Current Per Kilowatt-Hour - Cents								
	1.	1.5	2.	2.5	3.	3.5	4.	4.5	5.
	Per Horsepower Hour - Cents								
	.75	1.125	1.5	1.875	2.25	2.625	3.	3.375	3.75
16	.2	.3	.4	.5	.6	.7	.8	.9	1.0
18	.225	.337	.45	.562	.675	.787	.9	1.012	1.125
20	.25	.375	.5	.625	.75	.875	1.0	1.125	1.25
22	.275	.412	.55	.687	.825	.962	1.1	1.237	1.375
24	.3	.45	.6	.75	.9	1.05	1.2	1.35	1.5
26	.325	.487	.65	.812	.975	1.137	1.3	1.46	1.625
28	.35	.525	.7	.875	1.05	1.225	1.4	1.575	1.75
30	.375	.562	.75	.937	1.125	1.312	1.5	1.687	1.875

Example:- If it requires 22 Brake Horsepower to deliver 100 cubic feet of free air per minute at 90 lb. pressure, and electric current at 4. cents per kilowatt-hour, the electric current cost per 100 cubic feet of free air is 1.1 cents.

H. V. Conrad.

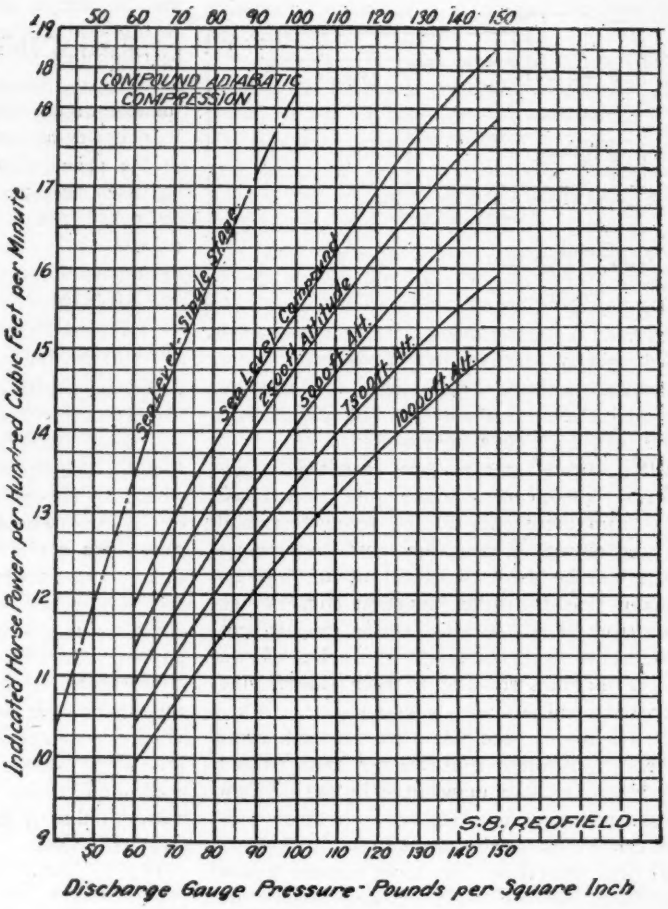
instead of gasoline, the price per gallon should be determined, also the consumption per brake horsepower.

In Table III, it is assumed that the consumer may wish to buy electric current from some power plant.

The figures in all the tables are given in multiples so that missing ones can readily be determined; for illustration, if 100 cu. ft. of free air requires 10 hp., ½ the horizontal column of 20 or ⅓ of 30 can be taken. If gasoline costs 20c., multiply by 2 the column given under 10c. If electric current costs 6c., multiply by 2 the column given under 3c.

These tables can be used to advantage in considering a plant of any size or efficiency.

NOTE.—In the cost figures the element of time need not be considered in compressing 100 cu. ft. of air, whether it requires ¼ min., ½, etc., to do the work.—*Practical Engineer.*



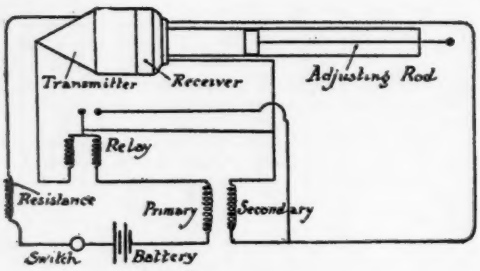
HORSE POWER DIAGRAM.

DISTANT CONTROL OF AIRCRAFT BY RESONANCE

An Australian inventor has developed an ingenious device which may be employed for directing and controlling aircraft from a distance, and is claimed to possess advantage over wireless methods in that its operation cannot be interfered with by enemies or others. The following descriptive sketch is taken from *Flight,* London, whose representative was permitted to witness a demonstration.

The leading idea of the device is found in the well known principle of sympathetic resonance. This may be readily demonstrated by the simple experiment of pressing down the "loud" pedal of a piano and playing a note on some other instrument—a violin, for instance. The corresponding note will then sound on the piano.

The resonator consists fundamentally of a telephone transmitter and receiver, facing one another and placed a short distance apart, the space between them being enclosed in a cylindrical casing which confines the air, thus amplifying the reaction between transmitter and receiver. To the back of the receiver is attached a tube in which works a piston operated by a short rod. By moving the piston in and out the length of the air column behind the receiver is changed, and consequently the note emitted when the diaphragms of transmitter and receiver are vibrated is altered correspondingly. The principle of the whole arrangement will be better and more easily understood by reference to the accompanying



SKETCH OF AIRCRAFT CONTROL.

diagram. The telephone transmitter is coupled to the primary current and the receiver to the secondary current. From one of the terminals of the transmitter a wire runs through a suitable resistance, to a switch, hence through a battery, through the primary circuit of an induction coil, to an ordinary post office relay, and from there back to the second terminal of transmitter. The wiring from the receiver is, it will be seen, connected up to the secondary circuit of the induction coil. When the armature of the relay moves over it provides short circuiting by the two wires shown in the diagram running to each side of the secondary coil.

It will now be seen that when the diaphragms of the transmitter and receiver are vibrated by the proper note, determined by the position of the piston in the tube, and no other note will cause them to vibrate, the relay is brought into play and closes the local current which may then be used, via suitable means, of course, for starting or stopping an engine, operating control surfaces, releasing bombs, etc.

In the model framework of a dirigible on which the principle of distant control was demonstrated, there were, as we have already indicated, three small electromotors, each driving a propeller. As demonstrated the sequence of operation of the three motors was, in fact, predetermined by reason of the multiple switch employed for throwing them into gear, the same note being used for initiating the control of all the motors. When rigged up for actual use on aircraft each motor and movement would have its particular note, so that no fixed sequence would have to be followed. Thus, for instance, one note would correspond to right rudder, one to left rudder; one to elevating, one to depressing; one to accelerating the engine, and one to throttling it down. In this way any evolution of an aircraft could be controlled from the ground, the necessary notes being produced by some suitable instrument, as, for instance, a siren, in which the note could be altered by varying the speed of the siren. Care would, of course, have to be taken that no note likely to be produced on board the aircraft itself, either by the engines or by the bracing wires humming in the current of air, was employed for control. In fact, there seems to be no reason why notes of such a pitch as to be inaudible to the human ear should not be employed.

On the model demonstrated it was possible to set the machinery in motion by running up and down the scale until the right note was found. The inventor claims, however, that it would be a very simple matter to arrange a combination whereby it would be necessary to sound the given note, not once but several times, with predetermined intervals, before the result was obtained, thus providing in effect an equivalent to the combinations used on safes, and absolutely preventing outside interference. It is mainly in this respect, we understand, that the inventor claims superiority of the resonance method over the wireless system, in which latter a coherer must be used, and which is therefore open to the criticism that it may comparatively easily be interfered with.

As regards the practical utility of this very ingenious device to aircraft work, the number of forms this might take appears to be legion, and although many difficulties suggest themselves, doubtless they can be overcome. Even if they cannot, that does not detract in the least from the ingeniousness of the device. The inventor has, as already mentioned, ample scope for the application of the device to other fields of engineering. Thus, for instance, for telegraphic purposes the resonator renders possible the sending of a great number of telegrams over one wire simultaneously, with the further advantage that "tapping" the wire can be made practically impossible. Communication can be maintained between a central station and each of a number of trains, thus minimizing the danger of collision, and there are numerous other applications possible. which we cannot deal with here

SAFE AIR-COMPRESSOR OPERATION

BY. M. A. SALLER

In connection with the installation and operation of air-compressing equipment, there are many factors and considerations that may be overlooked or neglected, and thereby result in extreme hazard to the operators, to say nothing of unsatisfactory operation and poor economy.

Probably the first and most important consideration is the compressor itself. The capacity of the equipment should be adequate to meet the requirements for air at the proper pressure and at normal operating speeds. Extreme overloading results in too high piston speeds, and dangerous velocities through the air valves cause inefficient results and present a source of positive danger. A piston travel of 500 ft. per minute, while maintaining full capacity and pressure, should not be exceeded.

Excessive piston speed is often caused by leaky valves and pipe connections, which throw an excessive and unnecessary burden on the compressor. A leak in an air line is just as worthy of attention as a leak in a steam line; therefore frequent inspections should be made to see that they are tight.

The question of flywheel speed should also be given consideration. This is even more important than in ordinary engine work, because of the tremendous strain and high overloads to which compressor flywheels are subjected, owing to frequent and sudden load changes. With a cast-iron one-piece flywheel, a peripheral speed of 5000 ft. per min. should never be exceeded. If the flywheel is of light construction, a speed of 3000 ft. per min. should be the maximum. If the flywheel is made up of flanged sections bolted together, the speed limit should be reduced even further according to the known or calculated strength of the joint construction. In figuring these speeds, the determining factor is the maximum speed of the flywheel when acting under the impulse of the most sudden change of load.

Because of fluctuating and sudden changing of load imposed on a compressor, setting up severe shocks and jars, care should be exercised in locating and building the foundation, which should be of concrete wherever possible in order to minimize the strains on the equipment itself and to prevent, as much as possible, the transmission of jar and vibration to the building.

Another source of considerable trouble and loss of efficiency is in connection with the condition of the air supplied to the compressors. The air intake should be located where dust and grit are not prevalent. Consideration should also be given to the temperature of the air available, since the cooler the air the less heat will be generated in the compressor. Where dust in the air intake cannot be avoided, arrangements should be made to filter the air through a muslin screen before it is delivered to the compressor intake, or else air-washing apparatus should be installed.

All air pipes in connection with compressing units should be designed with as much care and intelligence as are high-pressure steam lines, both as to capacity and the elimination of avoidable sharp turns. This is to prevent any excessive drop in pressure because of undue resistance in the pipe line, and also to minimize as much as possible vibration or pulsation. Air piping should also be arranged and drained to avoid pockets in which water can accumulate.

AIR-LINE TEMPERATURE

The range of temperature in air lines is frequently very considerable because of varying pressures and compression conditions. The piping should be arranged with provision for the free expansion of all parts, otherwise excessive strains, possibly resulting in rupture, may be placed on different fittings or on the compressor itself.

In steam-driven compressors the rush of live steam into the steam cylinder in response to the sudden changes in load is sometimes dangerous because of the liability of pulling over slugs of water. It is desirable to place a steam separator on the steam line to every unit, both from the standpoint of safety and to assist in securing the best lubrication at the minimum expense for oil, as the elimination of the water in the steam prevents washing the oil from the cylinder walls.

It is desirable to insulate or cover exposed steam or hot-air piping—the former from an economical standpoint to prevent extreme radiation losses, and the latter to protect the burning of operators who may come in contact with the exposed pipes.

Of utmost importanee in connection with

continuously operating or heavy-duty compressors is that of securing a reliable and generous source of cooling water. Failure of the cooling-water supply in the case of a compressor doing heavy duty will cause overheating and the consequent closing down of the apparatus. In order to know that the cooling water is being supplied, it is advisable to install a flow indicator in the cooling-water line, else arrange the overflow from the jacket so that it discharges into an open funnel where the flow is easily seen.

COOLING WATER

The quality of the cooling water is also of importance, because water containing considerable quantities of lime will cause the deposition of scale on the jacket walls, which seriously interferes with the heat exchange and presents a source of expense and trouble when it accumulates to such an extent that it must be removed. Cooling water obviously should not contain acids or other active agents that may cause the corrosion of the jacket lining.

Every air tank, however small, should be fitted with a reliable safety valve set to release at a pressure well within the limits of the strength of the tank and of sufficient size to release all excess air delivered to it, so that there will be no accumulation above the maximum pressure. On large tanks it is advisable to install at least two valves. A drain for drawing off such oil and water as may accumulate should also be provided in the bottom of the tank. It should be opened at regular intervals, from three to five times daily, according to the local conditions.

Explosions due to the spontaneous combustion of explosive gases within the compressor cylinder, pipe line or receiver tank present one of the greatest hazards in compressor operation. The responsibility for these explosions can be traced largely to the use of unsuitable lubricating oil, coupled with unsatisfactory operation.

The intense heat encountered in the compressor cylinder affects lubricating oil differently from the heat encountered in the steam-engine cylinder, where moisture is usually present. The dry condition of the air cylinder results in the burning of the oil into powder-like particles, which deposit on the cylinder walls, discharge valves and in the pipe line. This soot, when properly mixed with air, has great explosive tendencies when brought in contact with intense heat, and hence its accumulation is highly undesirable, as the temperature of the compressor cylinder and parts may suddenly be increased, owing to the failure of the cooling water, the clogging of the valve passages because of the soot itself, or the extreme overloading of the compressor.

This accumulation of carbon or soot is either the result of feeding excessive quantities of oil or of the use of a poor quality oil. The oil used in lubricating air-compressor cylinders should be of mineral derivation and should be free of all foreign matter, such as tar, which may tend toward the production of excessive carbon deposits. The oil should also be one with a high flash point; that is, one that will not ignite below 500 deg. The ordinary cylinder oil used in steam engines is not suitable for lubricating air cylinders, and a special grade of oil compounded for the service should be used.

DANGER FROM OIL

As there is a positive danger from feeding too much oil to an air compressor, pains should be taken to see that oil is fed at a uniform rate in just sufficient quantities to give the necessary lubrication. A drop or two of oil every five or seven minutes should be ample for the average machine. A record should be kept of the total amount of oil fed to the compressor each week, so that the feeding of any excess can be checked up.

It is advisable to inspect the cylinder, valves and piping whenever possible—and this should not be at longer intervals than two weeks—and any deposit of carbon and soot should be removed by mechanical means; that is, by scraping or cutting away, or by the application of soapy water or a solution of caustic soda and water. Kerosene or gasoline should never be used for removing carbon.

In connection with inspection work it should be remembered that whenever an air-compressor head is being removed care should be exercised in avoiding contact of the escaping gases with a flame, caused by the mixture of the air and vaporized oil, because a flare-up or explosion is liable to occur if the gas happens to be very dense. In all cases where repairs are being made or inspections carried out, the compressor should be allowed to stand

for a while to insure thorough cooling of all parts before the work is undertaken.

An aftercooler is used in the air-discharge line for cooling the air after compression, so that any moisture or oil contained therein will be condensed and separated from the air instead of being carried to the pipe line.

Frequently a fusible plug, containing a mixture that will melt at a certain predetermined temperature, is placed in the discharge valves. When the temperature rises above the predetermined point, the fusible metal is melted and the air is discharged with a whistling noise, which sounds the alarm that the temperature is rising and hence the valves or cooling water need attention. Recording thermometers installed in the air-discharge line also serve to give notice of undue rise in temperature in that they will indicate when there is a gradual increase in the temperature of the discharged air.

As pointed out, there are many factors in air-compressor operation that require careful and constant care and attention in order to secure efficient results and to prevent dangerous accidents, and the subject should therefore be considered in all its phases wherever apparatus of this kind is installed and placed in service.—*Power.*

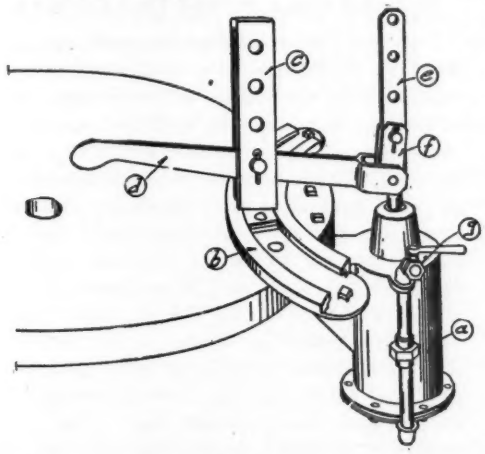


FIG. 1.

PNEUMATIC CLAMPING DEVICES

The handiness of compressed air is probably nowhere quite so highly appreciated as in railroad shops, and devices for its employment originate there so numerously that only a few of them get public mention. The clamping devices shown in the accompanying

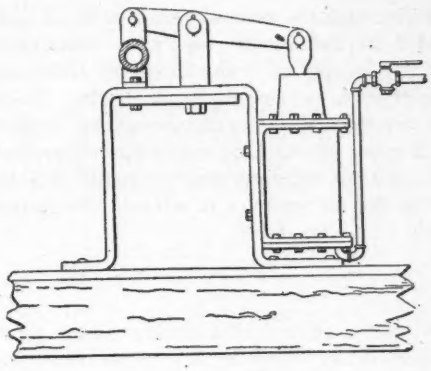


FIG. 2.

cuts require little explanation, their construction and operation being self evident.

Fig. 1, by F. P. Maize, M. M., Portland Ry., Lt. and Power Co., is for clamping work on a drill press table. Using bolts or even screw clamps for the purpose of secure and satisfactory clamping of the work might often take as much time as the drilling, but with the air clamp we might say it takes no time at all. The air cylinder is set alongside of the drill press and as its working pressure is always downward it only requires a level place to stand upon and no bolting. Admitting the air under the piston throws the outer end of the lever down upon the work with the force required to hold it there securely. The lever pins can be changed to the different holes for different heights of work, and the lever can also be swung sidewise as may be required.

Fig. 2 is a pipe vise or clamp which requires no explanation. It is naturally a fixture and can be located where most convenient. It is used as shown in shops of the Illinois Central Railroad, the cut from *Railroad and Locomotive Engineering.*

Fig. 3, from *Railway Mechanical Engineer,* is a chuck for a bolt threading machine used in the Reading shops of P. & R. The body of the chuck is clamped in the jaws of the

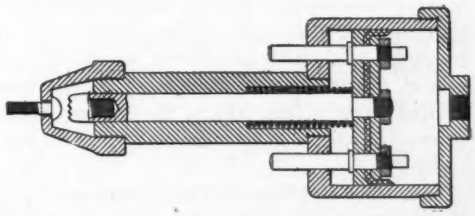
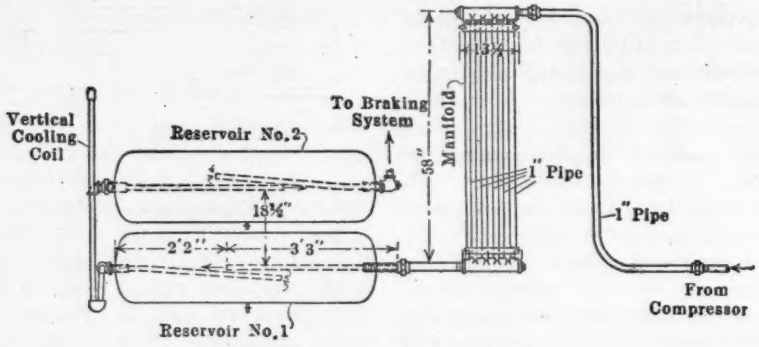


FIG. 3.

machine and the rear of the cylinder is connected to the nearest supply of compressed air. It is used as here shown for short size countersunk or button headed bolts. These are inserted or removed through an opening in the side of the cap and different caps are provided for different sizes or shapes of bolts. When the air pressure is released the springs push the piston back.

going pipe extends beyond the end of the incoming pipe, thus providing for good circulation of air in the reservoir. The air passes from the first reservoir to the vertical cooling coil. More of the remaining moisture will condense here and be carried into the second main reservoir, where it is removed as in the first one.

This scheme has worked out in a satisfactory manner during the past winter and is one that could readily be applied to any air-brake system.—*Electric Railway Journal.*



AFTERCOOLER FOR AIR BRAKE SERVICE.

AFTERCOOLER AND SEPARATOR IN AIR BRAKE SERVICE

BY J. J. SINCLAIR*

Each winter season brings out different methods of preventing the freezing of the water which condenses in the pipes of air-brake systems of cars. Since most of the moisture will condense where the cooling of the air takes place, it is essential to provide a means of removing this suspended water from the pipes before it is carried through into the air-brake system proper. The diagram shown herewith illustrates how this has been accomplished on the subway cars of the New York Municipal Railway.

The air coming from the compressor passes through the manifold which consists of five 1-in. pipes connected in parallel between headers. As the air is cooled in the manifold the moisture condenses and is carried along suspended in the air until it reaches the first main reservoir. It will be noticed that the incoming pipe is extended to within 2 ft. 2 in. of the end of the reservoir, which thereby acts as a baffle and removes much of the suspended water. This falls to the bottom of the reservoir, where it is drained off. The out-

*Assistant Engineer of Car Equipment, New York Municipal Railway, Brooklyn, N. Y.

FRENCH COAL MINES IN THE WAR

Lens and Lievin, which have just been captured by the British, after a German occupation of over two years, are very important, because of their mineral wealth. Lens has a population of about 30,000, but if the surrounding villages be added the number exceeds 40,000. Lievin alone has a population of 25,000. Lens was the scene of some fierce fighting during 1915, particularly at Loos and Hulluch, on the British flank, and Notre Dame de Lorette and Suchez on the French flank. Lens has been compared to Wigan, as the centre of a great coalfield. At Lievin 4,000 men were employed before the war, and the annual output of coal was 1,000,000 tons. The Lens mines, as a whole, before the war had an annual output of about 5,000,000 tons. The mines have been ruthlessly destroyed by the Huns on a systematic scale of devastation, which it took a fortnight to carry out. M. Reumaux, a director of the Lens mine, says it may be possible to recommence working in eight months, but more probably a year will be required to put the pits in order.

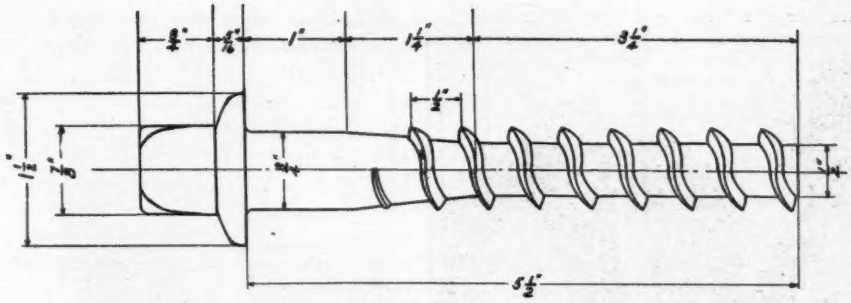


FIG. 1.

DRIVING SCREW SPIKES ON NEW YORK CONNECTING RAILROAD

BY H. L. HICKS

The New York Connecting Railroad linking the New York, New Haven and Hartford and Pennsylvania Railroad systems via the recently completed Hell Gate Bridge was recently opened for passenger traffic, work having been rushed for several weeks in laying the double track over which the trains were to run.

Particular interest attaches to the use of screw spikes to anchor the 125 pound rails. These spikes are of two types, one to hold the tie plates, (employed throughout) and a larger size for the rail itself. The first, Fig. 1, is about 6 inches long by ¾ inch diameter, the second, Fig. 2, is about 7⅝ inches long by ⅞ inch diameter and has a flange to grip the rail. Both have a heavy thread of ½ inch pitch and ⅞ inch square heads. Six spikes are used at each end of a tie, four for the tie plate and two for the rail.

These spikes are being driven pneumatically with highly satisfactory results. This class of work requires a machine readily handled and possessing exceptional power. The "Little David" No. 11 SE Reversible Drills Fig. 3, which are being used meet the conditions admirably. These tools have been fitted with a special driving socket which fits the spike heads. This has been made as short as possible, which makes the machine better balanced and more easily placed on the spike heads. The No. 11SE Drill is compound geared, weighs 70 pounds and operates at a speed of 100 R. P. M., consuming about 55 cu. ft. of air. The writer's observation of the time required for driving a single spike was an average of 5 seconds for the smaller spikes and an average of 6 seconds for the large ones. Under favorable conditions the six spikes in one end of a tie can be driven in about 45 seconds. No lubricant is used, unless the creosote with which the ties are treated can be so considered.

Ties are bored with ⅝ inch holes for tie plate spikes and ⅞ inch holes for rail spikes

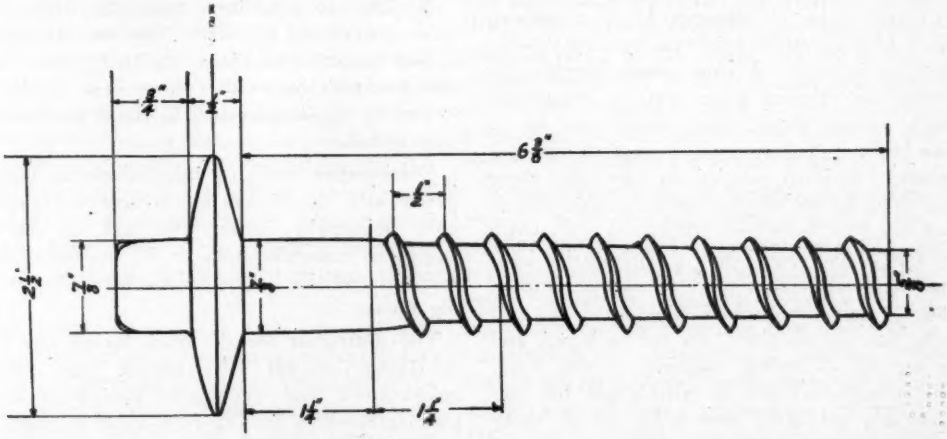


FIG. 2.

FIG. 3.

before being laid, but there are instances where the holes will not register with the tie plates and, as no tie plates are used at the rail joints, the spike holes for the fish plates also must be bored on the job. This work is done by "Little David" No. 13A Wood Boring Machines Fig. 4, about 10 seconds being required to bore a 5/8 inch hole through a tie.

Compressed air at 100 pounds pressure is supplied by two "Imperial" Type XII Gasoline Driven Portable Compressors, Fig. 5. These are duplex vertical compressors with cylinders 8 in. in diameter by 6 in. stroke, short belt driven by four-cylinder, tractor type gasoline motors. A cone clutch permits the load to be released when starting the motor. Each weighs about 5,600 pounds and has a rated piston displacement of 140 cu. ft. per minute. It is of interest to note that these machines, of the manufacturers standard road portable type, have been adapted to track work by the simple expedient of temporarily bolting a circular flanged piece to the rim of each wheel. Each compressor supplies air to two spike driving machines, one for each rail, and to the wood boring machine serving both. The compressors are operated about 100 feet apart and are easily moved by two or three men as the work progresses.

The labor required is as follows: an operator for each compressor, two men with wood boring machines and four gangs of five men, each gang consisting of two men to operate the "Little David," two men with crowbars and one with sledge to line up the ties and to hold them while the spikes are being run in. This is necessary because the air drills are so powerful that they slightly turn the tie as soon as the spike is solidly seated unless the tie is firmly held.

Ties, tie plates and rails are laid in advance of the spiking gang and all rail joints are completed. Much of the gang's time is devoted to straightening the ties and registering the spike holes with the rails. The average progress per 10 hour day has been twenty 33 foot rails with each compressor unit. At 20 ties per rail and 12 spikes per tie this totals 4,800 spikes, or 9,600 spikes for the two outfits.

The operating costs per day (10 hours) are approximately as follows:—

40 gallons gasoline at 23c	$9.20
1 gallon lubricating oil at 60c	.60
2 compressor operators at $3.50 and $3.00 per 9 hours	7.22
8 spike driving machine operators $2.75 per 9 hours	24.44
14 laborers at $2.50 per 9 hours	38.89
Miscellaneous supplies	1.00
	$81.45
Cost per spike	0.008

No charges have been made for depreciation or overhead expense. The item of compressor repairs has been omitted, based on the operator's report that there were no shutdowns or repairs necessary in running a month and a half.

Comparative costs of hand work, as compared with the above figures, are not available, principally because the use of screw spikes is generally held to be impracticable without a reliable means for mechanically driving them.

The contractor for the track laying was P McManus Inc., Mr. E. J. Horan, Supt. The compressors and pneumatic equipment are manufactured by the Ingersoll-Rand Company, New York.

FIG. 4.

FIG. 5.

COMMON SENSE ON THE METRIC SYSTEM

The following is from an unidentified correspondent, W. A., of *The Engineer,* London, and maintains the English local viewpoint all through. This being remembered, it should be entirely intelligible to our readers, and should be equally appreciated here.

In this controversy over units of measure the one point that should be prominent is usually ignored, I mean the convenience and custom of the users. There are about 530 million users of the British system, 300 million of the metric, *i. e.,* a ratio of 1.75 addicted to the foot and the pound. The balance of the world's population is 770 million, the majority of whom are as yet indifferent. These figures cannot make pretence to accuracy, but they give an idea of the proportion among the users.

The metric system has been optional and legal in this country for the past twenty years. As we cannot point to a large turnover to the metric system, we are bound to suppose that the folk who would make it compulsory must be determined to do us good against our wishes. Those who have adopted it have been for the most part persons engaged in research work, to whom undeniably, the convenience of a universal system is great. There are also a few engineering firms, mostly of continental origin, or directed by foreigners, who have brought with them a bias for the system to which they have been accustomed, just as we have a bias for the one we use.

Whilst dealing with the more general aspect of the question it should be noted that, at the time when France, Germany, and the Latin races adopted the metric system, they were hardly great manufacturers, whatever they may have become since. The users of the British system, who conjointly are the greatest manufacturers in the world, are to be confronted with a change of system in their present highly organized state,—a very different proposition to that which was faced by the nations who joined the metric league.

If the convenience of the user is the main issue, I think the advocates of metric compulsion should show much stronger reasons for the change than they have advanced hitherto. The metric system is largely urged on us by scientific men because they deal with a vast variety of substances and qualities. The metric system and its developments has offered the best solution of their requirements, so far. But it should be noted that it is *their*

convenience that is the deciding factor. The man engaged on research having found its advantages, presupposes that the same advantages would accrue to the cheesemonger, the tailor, the engineer, the printer, etc., and urges its compulsory adoption. I venture to think that this is a great error. The ordinary man of business, or workman, generally has a very limited number of materials and qualities to deal with. Beyond representing the specific gravity of a substance and its density by the same number, I cannot see much gain to the vast body of the community. Moreover, the numbers for these qualities are equally difficult to remember in any system.

The virtues, if any, to be obtained by a decimal system cannot, of course, be claimed for metric measures—it is a system open to any weights and measures. With the exception of our ten "pickers and stealers," the remainder of the realm of Nature seems adverse to the decimal system. A cow or a milkmaid constructed on the decimal system would be a curiosity, for which nations would contend! We must therefore come to the conclusion that the advantage of the metric methods lies in the absolute values of the units selected. It comes to this, then, we, the majority, are requested to bear all the expense and inconvenience of changing our yard for a measure about 3⅓ in. longer, and our standard of weight for one which is just a little more than double! It seems to me an abjectly preposterous proposition.

Systems of weights and measures must be adapted to the requirements and conveniences of the user. Look, for example, at the units of length which the metric system itself has developed—

Tenth metre	$= 10^{-10}$	metre
1 $\mu\mu$ or millimicron	$= 10^{-9}$	,,
1 μ or micron	$= 10^{-6}$	,,
Millimetre	$= 10^{-3}$	,,
Centimetre	$= 10^{-2}$	,,
Decimetre	$= 10^{-1}$	,,
Metre	$= 1$	,,
Decametre	$= 10$	,,
Hectometre	$= 10^{2}$	,,
Kilometre	$= 10^{3}$	,,

No less than ten values.

From my knowledge of children, I know that to connect these names with the various plus and minus powers of ten would be at least equally confusing as the statement that 12 in. make one foot, 3 ft. one yard, etc. Scientists have added a further unit called a "light year," solely for the reason of convenience.

There is considerable difficulty in defending the various national measures, because they have grown up with the life of the nation. All such relationships which are complex—the franchise, monogamous marriage, etc.—are difficult to defend against a show of misleading simplicity. One of the best tests is convenience to the user. I reiterate this. If in a hilly country like Switzerland, you ask how far it is to the village you are walking to, you will receive your answer in hours. It is absolutely indefensible from the scientific point of view, and is, indeed, open to ridicule, but it is much more convenient than miles or kilometres under the circumstances.

What becomes of the vaunted simplicity in the case of a farmer who wants so many cwt. of "artificial" to the acre, or so many kilos, per hectare? Let us suppose the metric figures are always the simplest. The fertilizer refuses to maintain a metric purity, so, when buying, the farmer must divide by some figure lying between .55 and .95 and, to adapt Kipling, as the vanishing zebra said to the Ethiopian "One—two—three—and where's your simplicity?" Will that convenient measure, the drop, become illegal? How was it the French Directory failed to enforce its months, or its circle divided into 400 degrees? For a terribly vulgar reason—because it wasn't worth it. Why is so much spoken in praise of the thermometer that is divided with 100 parts between freezing and boiling points, over that divided into 180 parts? Nearly all phenomena are best referred to absolute values of temperature. In the former case, 273 deg. have to be added. Is there some magic value in 273 over the 469 required in the Fahrenheit scale.

Our own British system is much maligned, due largely to the makers of elementary arithmetic books. These worthies seek outrageous conversions for the confusion of the minds they are supposed to educate. Much of the ridicule cast on the British system by metricists arises from ignorance. The coal merchant deals in tons, and should he ever require to deal in grains, he can find the information ready to hand in Whitaker, just as I am sure a draper who dealt in metres would go to a "table" to find out the value of a micron. To enjoy the company of the Pro-

gressives it is necessary to over-rate the value of ten as a factor. The ancient Greeks, who were practical as well as intellectual, knew that the mind worked in ratios, or proportions, consequently they selected, where practicable, such multiples as 12, 24, 360, etc.

Even in such cases as fitting where the goodness is measured more by differences than ratios, the work is not hampered, because the unit has a large and convenient number of factors.

Before the war we had fits of nerves, and got the idea that anything but what we have must be an improvement. Are we not in the same way over this metric business? We are proposing to burden the English speaking race with a tax that will, I suppose, reach 100 million sterling. For whose good? And all this to be done to substitute for a yard of 36 in. a length called a metre, which is 39. 37 in., and which possesses the unique merit of being 10^{-7} part of an earth quadrant accurately measured, and subject to variation with time.

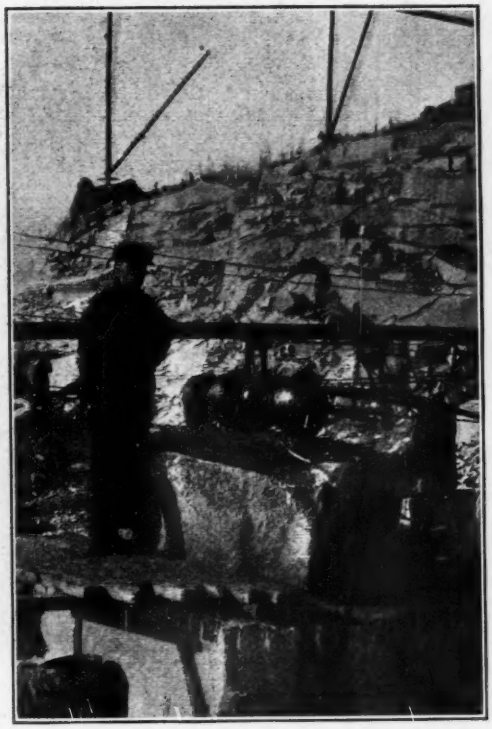
When faced with a proposition of such vast import it savours of fraudulence to mix up with a decimal system. Anyone is at liberty to decimalize the yard or the foot or pound or anything else. Indeed, it is frequent in certain classes of work.

So far as education is concerned, it is vapid to talk about the ease of multiplying by ten. We do not always require either ten times our unit, or a tenth of it, and I would further suggest that it is quite as essential for a child to learn to multiply and divide by 2, 3, 4, 5, 6, 7, 8, and 9 as well as by ten. If we must have a change let us at least choose a sounder basis than the metric, and let us all begin on it alike, so that all start with a level handicap.

TWO BABY HOISTS RUN A DISABLED DERRICK

BY H. L. HICKS

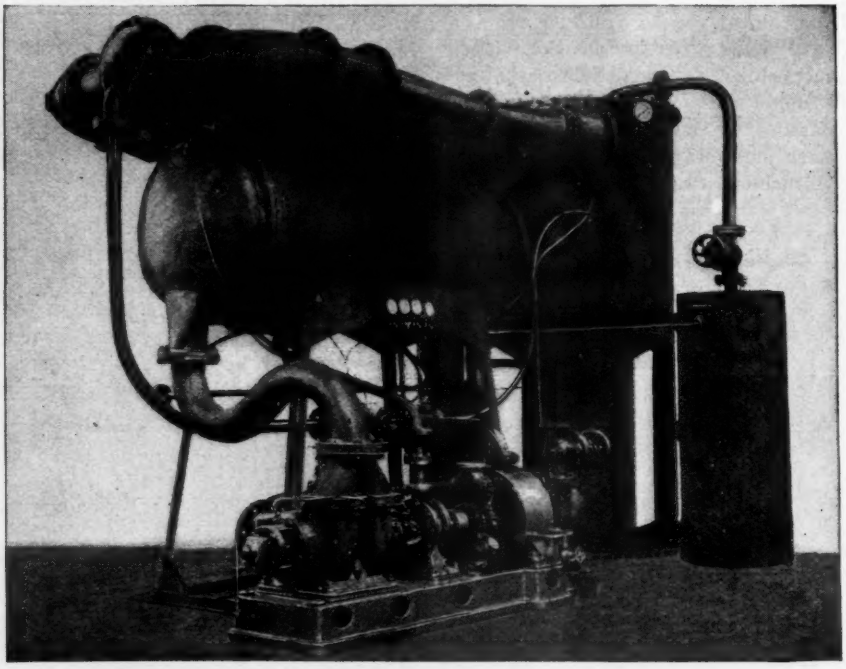
Two little tugger portable air hoists were substituted recently for the regular swinging gear used to operate a large quarry derrick in Vermont while the regular engine was being repaired. As the derrick—the largest of those in use—was important to continuous operation, the quarry was practically tied up by an accident to its swinger. The superintendent, however, quickly improvised a new



swinging gear by bolting the two "little tuggers" side by side to 2-in. planks, which in turn were changed to two large blocks of granite, as shown in the photograph. The lines from the hoists were led to opposite sides of the bullwheel, one being used to turn the derrick in one direction and the other to swing it back. This improvised arrangement kept the derrick in operation more than a week while the regular swinging engine was being repaired. In ordinary service one of these little hoists is used to overhaul the heavy cable from one of the derricks across the quarry pit, while the other is used in lowering steels and light loads into the pits.

The rig described was used in the Montpelier (Vt.) quarry of the Wetmore & Morse Granite Company.

The wide usefulness of first aid training in and about the collieries of the anthracite field is illustrated in the announcement that men who have received this training are to take steps looking to the formation of a hospital corps which may be very much needed in the present war.



LEBLANC REFRIGERATING MACHINE FOR LOW BRINE TEMPERATURE USING A SURFACE CONDENSER AND TURBINE DRIVEN PUMPS.

REFRIGERATION BY VACUUM PROCESS AND WITHOUT GAS COMPRESSION

BY WILLIAM H. EASTON.

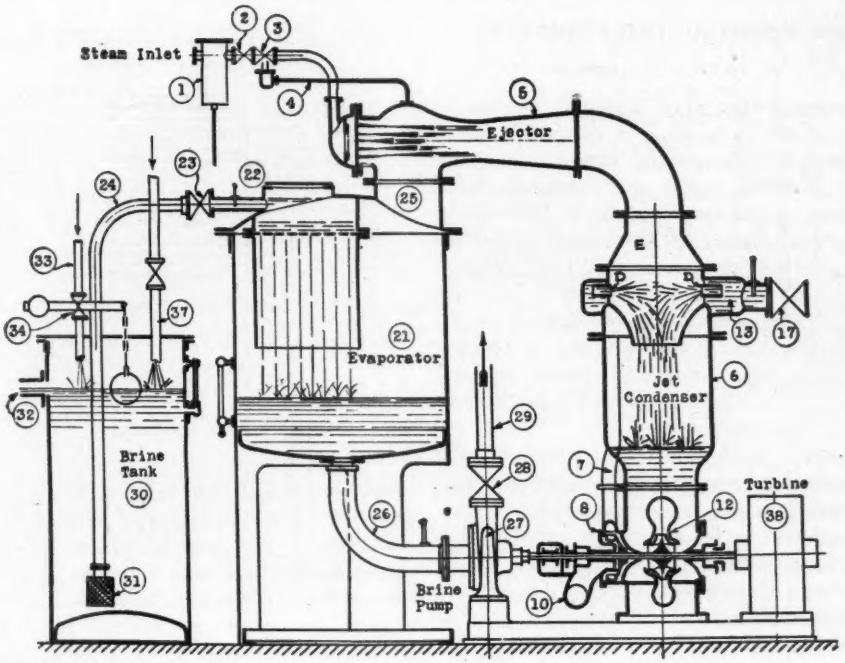
So general is the use of a compressed gas of some kind, such as ammonia, carbon dioxide, etc., for mechanical refrigeration, that a machine that operates with neither a gas of this sort nor under high pressures is regarded as almost a curiosity. For this reason, the newly developed Westinghouse Leblanc refrigerating machine has awakened considerable interest.

The actual refrigerating element in this machine is simply a brine solution, (or even pure water where temperatures below freezing are not wanted) and the principle it employs has literally been used for cooling from time immemorial. Briefly, this principle is as follows:

Everyone knows that the evaporation of water produces a cooling effect, and that if water is rapidly evaporated in a high vacuumn the cooling will be so intense that part of the water will freeze. Now referring to the diagram, Fig. 2, 30 is a reservoir containing the brine solution; 21 a large tank called the evaporator; 6 a condenser; and 8 an air pump. By means of the air pump the whole system beyond valve 23 is kept at a high vacuum. It is evident, therefore, that by opening valve 23 the brine solution will be drawn into the evaporator. Here it passes through a sieve and falls as a fine spray.

As the vacuum in the evaporator is high, a large part of this spray is evaporated, and in the act of evaporation, it absorbs a great deal of heat. There is only one source for this heat, however, and that is that part of the spray which does not evaporate. This portion, then, falls to the bottom at a low temperature, is drawn off by pump 27, is distributed whereever wanted for ice making or refrigerating purposes, and returned to reservoir 30.

Of course the vapors formed in the evaporator would soon reduce the vacuum and check the process, so they must be promptly removed. They rise in pipe 25, and here they meet a steam jet from an ejector, which sweeps them into the condenser where both vapors and steam are condensed. The condenser shown is of the jet type, but any other kind may be

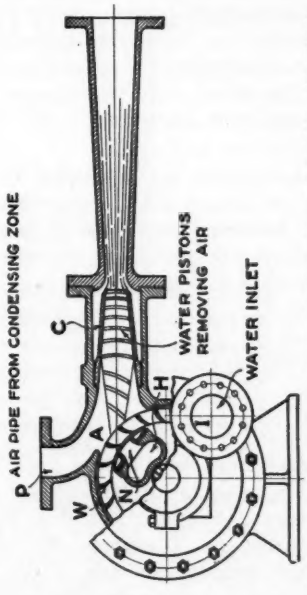


DIAGRAMMATIC ARRANGEMENT OF WESTINGHOUSE-LEBLANC REFRIGERATING MACHINE.

used, surface condensers being necessary on ship board.

The efficiency of the process depends on the maintenance of a high vacuum, and though attempts have been made in the past to utilize this simple principle they failed for want of an effective air pump. Hence the success of this machine can be largely credited to the Leblanc air pump, No. 8. An enlarged diagram of this pump is shown in Fig. 3. It is similar to an ordinary centrifugal pump in construction but has two inlets, one for water and one for air. The water discharges through the outlet, and in doing so carries the air along with it by the formation of pistons, similar to the action of the well known mercury pump. As there is no air leakage back into the system there is no difficulty in maintaining the necessary high vacuum.

The absence of a gas at a high pressure evidently eliminates all danger from explosion or gas leakage. Nor are any of the essential materials—water, salt, and steam—difficult to obtain in any part of the world, which is a matter of importance to a ship at sea. The size and weight of these machines are about one half of those of compressor machines of similar capacities, and the efficiency of operation is quite as good.



CROSS-SECTIONAL VIEW OF WESTINGHOUSE-LEBLANC AIR PUMP SHOWING PRINCIPLE OF OPERATION.

The shrinkage of manganese steel castings amounts to $^{5}/_{16}$ inch per foot as against $^{3}/_{16}$ inch to ¼ inch in ordinary steel foundry practice.

AIR WASHING AND PURIFYING

BY CHARLES L. HUBBARD

Of equal importance with the volume of air supplied to a building is its quality, which is especially true in the case of hospitals, schools, banking rooms and industrial plants. The conditioning of air relates to the removal of dust, regulation of the humidity and the cooling of it in summer. When buildings are in crowded localities the air is more or less filled with soot and street dust, especially at certain seasons of the year, and its removal in the instances mentioned is a matter of much importance, both on the score of healthfulness and of cleanliness.

Humidity is an important factor in good ventilation, as too dry an atmosphere produces an irritation or dryness of the respiratory passages, while too much moisture has a depressing effect.

Heating air causes the relative humidity of it to drop rapidly, as this is entirely dependent upon the temperature, and varies in an inverse ratio. The normal humidity of the external atmosphere varies from 40 to 70 per cent. of saturation in this climate, and it is desirable to maintain an inside humidity of 50 to 60 per cent., according to the character of the building. The effect of heating the air without moistening it is illustrated by the following figures:

Temp. of outside air	Relative humidity of outside air	Relative humidity of inside air when heated to 65 degrees
0 deg.	50 per cent.	3.5 per cent.
	70 per cent.	5.0 per cent.
20 deg.	50 per cent.	9.1 per cent.
	70 per cent.	12.7 per cent.
50 deg.	50 per cent.	30.1 per cent.
	70 per cent.	42.0 per cent.

It is evident from these figures that if outside air at a temperature around zero, but having a normal humidity of 50 to 70 per cent., is warmed to 65 degrees, the relative humidity will drop to 3.5 and 5 per cent., respectively, which is dryer than the most arid regions.

Too dry an atmosphere is not only irritating to the air passages, but it produces a feeling of chillness, due to the rapid evaporation from the surface of the body.

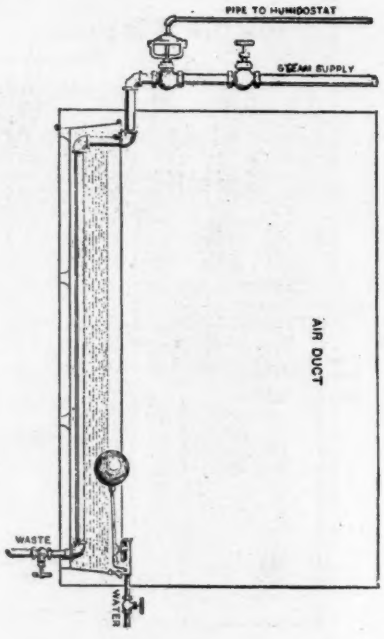


FIG. 1.

Experience shows that a room maintained at 65 degrees and 50 to 55 per cent. relative humidity, feels warmer than a room at 70 to 75 degrees with a humidity of only 30 to 35 per cent.

When a building is located in the open country, or in the outskirts of a town or city where the air is free from dust and soot, filtering may often be dispensed with provided some means is furnished for adding moisture to the entering air. There are different methods of doing this, depending somewhat upon circumstances.

If the temperature of the entering air does not exceed about 70 degrees the humidifier may be placed in the main supply duct.

When steam is available and is clean and odorless, a perforated pipe in the air duct forms a simple method. Sometimes a fine spray of warm water in place of steam is used. When neither steam jet nor water is advisable an evaporating pan forms a good arrangement. This is shown in Fig. 1, where as will be noted, a steam coil is immersed in the water to heat it to the evaporating point. An automatic device called a humidostat, controls the steam supply by means of a diaphragm valve, and the water is kept at a constant level in the pan by using a ball cock.

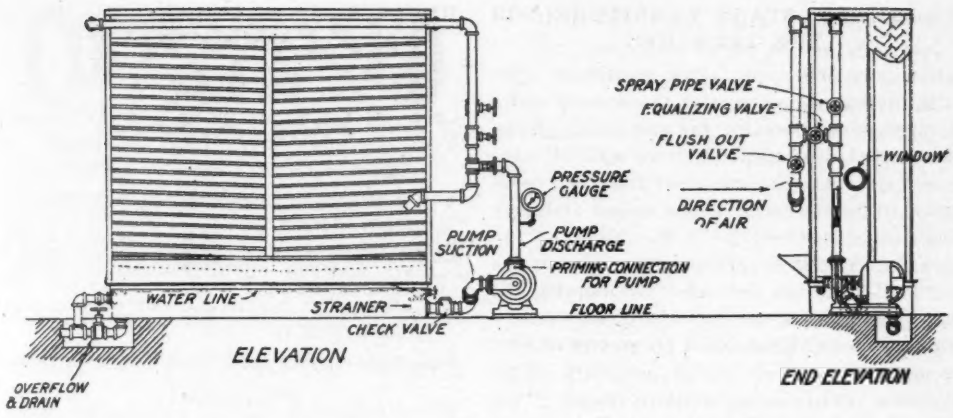


FIG. 2.

When the removal of dust is necessary some form of washer or spray filter gives the best results. A device of this kind is especially useful in this class of work because the removal of dust, regulation of humidity, and cooling of the air in summer, may all be combined in the same apparatus. A typical air washer is shown in plan and elevation in Fig. 2. It consists essentially of a series of spray nozzles for producing a warm curtain; and an eliminator for removing the entrained spray from the air after passing through the curtain. Pressure for producing the spray is furnished by a small centrifugal pump, usually driven by an independent electric motor. The eliminator is made up of a series of specially formed baffle plates inclosed in a metal casing. The spray water falls into a tank below the eliminator and is used repeatedly until the accumulation of dirt makes it necessary to change it.

Air washers are placed between the inlet window and the fan, and also between two heaters, known as tempering and secondary heaters, respectively, the first of these is for raising the temperature of the entering air above the freezing point, and the second for bringing it up to the desired temperature for delivery to the rooms.

A device of this kind is made to serve for the control of humidity by maintaining a proper relation between the temperature of the air entering the spray chamber and the spray water itself, thus regulating the amount of evaporation, which is due entirely to the temperature.

The temperature of the air is regulated by means of the tempering coil, and the water, either by a steam coil or steam and water mixer in the tank beneath the eliminator, all of which are under automatic control.

Standard makes of apparatus of this kind guarantee to maintain at a predetermined room temperature a relative humidity within 5 per cent. above or below that desired, as long as the wet-bulb temperature outside does not exceed the dew point temperature desired in the building.

Air cooling is accomplished by evaporation and is therefore greater with a fine or mist spray. It is evident that the dryer the entering air, the greater will be the evaporation, and, consequently, the greater the cooling effect. A considerable amount of cooling may be obtained by re-circulating the spray water, but will be considerably increased by the use of running water, either from a deep well or city supply.

Relative humidity of outside air	Cooling effect, with spray water at 75 deg.	Cooling effect, with spray water at 55 deg.
40 per cent.	4.5 degs.	13.0 degs.
50 per cent.	4.0 degs.	12.5 degs.
60 per cent.	3.5 degs.	12.0 degs.
70 per cent.	3.0 degs.	11.5 degs.

The above table, based on an outside temperature of 80 degrees, gives the approximate cooling effect for different degrees of humidity, and with spray water at two different temperatures.—*Southern Engineer.*

PNEUMATIC STAGE FURNITURE FOR THE TRENCHES

From an impromptu affair held in the open with the natural setting for the scenery and a number of soldiers for the cast, the soldiers' theatre has developed into a recognized institution. To-day the theatres in the war zone boast of real scenery, a real stage, and very often real players.

With characteristic Teuton thoroughness the Germans have not been slow in adopting the war theatre idea and in developing the mechanical end of it. Their latest progress has been in the direction of special pneumatic stage furniture which, when inflated, takes on the forms of a table, piano, sofa, chairs and so on, according to the requirements of the play. The pressure employed for inflating the furniture is sufficient to make it fairly rigid, so that the effect is highly realistic.

For transportation purposes the pneumatic stage furniture is deflated, whereupon it collapses and can be rolled up into a comparatively small bundle. To simplify matters each pneumatic "prop" or set is made in one piece, the carpet serving to join the various members together.—*Scientific American.*

BY-PRODUCT POTASH

According to U. S. Consul Chester Martin, of Toronto, Canada, a newspaper of that city states that a company making Portland cement at Durham, Ontario, is now turning out as a by-product from the feldspar twelve to sixteen tons of potash daily. Feldspar rock is added to the limestone as a raw material for cement, and a process has been evolved for collecting the liberated potash. Both muriates and caustic products are produced, and while the market standard of the former is fixed at eighty per cent. to the trade, the company claims that it is possible to produce an article which is almost pure.

The cost of manufacturing potash in Canada from feldspar is so low even now that it is less than the freight charge paid on a ton of the imported German products before the war. The result of this discovery will be the complete breaking of the German monopoly. In addition to guaranteeing a much-needed supply of potash for the present urgent demands, it will result in meeting the needs of the American Continent for fertilizers.

UNCLE SAM'S MILLIONS AND UNCLE SAM'S MEN

BY BERTON BRALEY

Cheer up, Tommy Atkins and Johnny Crapaud,
Your road has been weary and bloody, we know;
You've fought through discouragement, sorrow, defeat,
When failure seemed certain and gloom was complete;
But always our hearts and our prayers were with you
And now all our wealth and our power are too;
We've picked up the sword, and we've laid down the pen
And Uncle Sam's coming with millions and men!

Our vessels shall come to you loaded with grain,
So many the U-boats will fight them in vain;
From mills and from shops, from farms and from mines,
Munitions and foodstuffs shall come to your lines;
And soon we shall send, with our steel and our guns,
A million or so of our gallantest sons;
We'll help to bring peace to the world once again
With Uncle Sam's millions and Uncle Sam's men!

We hate all the bloodshed and horror of war,
But freedom and justice are worth fighting for;
And therefore we join with your battle-scarred clan
To make the world safe for the future of man;
Fight on, brother nations, be steadfast of heart,
We're coming to join you and take up our part,
To fight till democracy conquers again
With Uncle Sam's millions and Uncle Sam's men!

—*American Machinist.*

The cement gun was used with success and satisfaction for the cement lining 1¾ inches thick applied with an air pressure of 35 lb. gage, to the interiors of five large steel smoke stacks recently built for the Ford Motor Company, Detroit.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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CONTENTS

Saving by Scrapping Compressors..... 8387
Compressor Thirty Years Old..... 8390
Disaster to Alaska-Treadwell Mines.... 8390
Cost of Compressing Air..... 8391
Control of Aircraft by Resonance..... 8393
Safe Air Compressor Operation..... 8395
Pneumatic Clamping Devices..... 8397
Aftercooler for Air Brake Service..... 8398
French Coal Mines in the War..... 8398
Driving Screw Spikes in Railroad Ties.. 8399
Common Sense on the Metric System... 8401
Baby Hoists Run a Derrick..... 8403
Refrigeration by Vacuum Process..... 8404
Air Washing and Purifying..... 8406
Pneumatic Stage Furniture for the Trenches 8408
By-Product Potash 8408
Uncle Sam's Millions and Uncle Sam's Men 8408
Drop it Till the War is Over..... 8409
Intercooler Efficiencies 8410
Notes 8413
Patents 8415

DROP IT TILL THE WAR IS OVER

It is not to the credit of the advocates of the compulsory adoption of the metric system that they have pounced upon this time so inopportune for the renewed urging of their fad. When the fate of the world for generations is in the balance what matters it whether we are to do our measuring by metres or by yards? It is especially to be wondered at that the pushing of the metric system should be started up with such vigor at this time, since there is no business or pecuniary interest behind it, or any substantial thing apparently to be gained by its successful advocacy.

If there is anything that the metricists, individually or collectively, can claim it is that they are disinterested. They are not working for dollars and cents for themselves but for the good of the world, for the convenience and ultimate benefit of humanity, don't you know? Now, no great thing, such as its advocates assume this to be, is ever accomplished by disinterestedness. Disinterested workers can show but one dependable product. They are the world's mischief makers, and the most that can be expected when the trouble is over is change without improvement. The metric system involves many changes and possibly some improvements, but it brings with it also inherent inconveniences of its own which cannot be eliminated. The universal adoption of it would certainly not be final. Some clearer sighted innovaters, who even now are sufficiently in evidence, would be as clamorous as the metricists are now for another and perhaps a more revolutionary change. If any one will look into it, a system of duodecimal notation, with unlimited subdivisions by twos and threes, and using the yard and the quarter inch as basic units, would be vastly more convenient and more easily reconcilable with existing standards.

The opposition to the compulsory adoption of the system is in essential character as far as possible from the sentimental metric propaganda. There is no possibility of pretended disinterestedness there. There is call for strenuous action in defense. Not only are inconvenience and confusion involved in the proposed change, but enormous expense would be involved. This expense would not be in manufacturing operations but in the changes in tools, gages, and machinery involved. This would not be in these things merely the

changing of the new for the old, the replacing of the one by the other, but the continued maintenance of both almost without limit of time.

All this has been argued over and over, and it is useless to try to push it farther, but it might be worth while to try to imagine what would occur, for instance, in the Navy of the United States if Congress in its boundless wisdom should make the proposed change imperative. We need not say anything of the armament but think only of the machinery. Everything up to now, and without any planning, has been built to the old standards. The engines, generators, motors, pumps and auxiliary apparatus, are composed of innumerable details and all these details are interchangeable and would fit in their respective places not only all through each ship, but from ship to ship all through any fleet or the entire navy. This applies to bolts, nuts, screws, pins, rivets, pipes, pipe-fittings, valves, etc.

Now, suppose that all our ships from any given date, not remote, are built to metric measurements. These in detail, we may assume, would have the same interchangeability as in the older ships, but the ships old and new would have no interchangeability of parts from one to the other; and so for the maintenance of the ships and the replacement of parts, for repairs or otherwise, it would be necessary to carry a complete stock of both metric and non-metric parts and to maintain indefinitely the machinery and tools for the manufacture of each.

This is only a slight suggestion of the additional complications involved, to say nothing of the misunderstandings and mistakes in making and supplying which would inevitably become more frequent. We might show troubles of the same kind through all the details of our naval equipment, through army material and the merchant service. We could not suggest any line of human activity which has to do with the doing of things material which would not be inconvenienced. And all for what? We can well afford to wait for an adequate and satisfactory answer until the war is over.

For opposition to the metric agitation at the present time, saying nothing of the intrinsic merits of the case, there is ample justification; for its persistent advocacy there is none.

INTERCOOLER EFFICIENCIES

[The following correspondence, reproduced from *Practical Engineer,* May 15, refers to an article with the above title in the April issue of COMPRESSED AIR MAGAZINE, which article also was first printed in *Practical Engineer.* In the editing of the letter of Mr. Richards for the dignified columns of *Practical Engineer,* a few of its sentences disappeared; the letter is here presented precisely as originally written]:

DEAR SIR:—I have read with careful consideration the article in the Mar. 15 issue of *Practical Engineer,* by Frank Richards, on Intercooler Efficiencies, in which he says it will not increase the volumetric efficiency, or reduce the horsepower required to operate an air compressor, to remove the moisture or water from the air passing through the intercooler.

I beg to take exception to his view and give one experience I had along this line, while I was employed as superintendent of a large manufacturing plant in the West, a position I held for over 30 years.

In 1912, our firm secured a contract to build about 8 miles of 24 and 30-in. steel riveted pipe, No. 5 steel, to stand a working pressure of 125 lb. per square inch. We were under contract to deliver 400 ft. per day. We had a 580-cu. ft. two-stage air compressor of a well known make equipped with the Standard intercooler.

When we started work on our pipe line, we were running the compressor at its catalog speed of 160 r. p. m. using a 150-hp. General Electric motor. Our voltage was high, but our motor ran hot, and showed plainly that we were using all its power. We broke two-cylinder heads on the low-pressure side and it was all we could do to keep the compressor in running order, and we could get air enough even at 80 lb. pressure to operate but little over one-half of the equipment required to make the 400 ft. of pipe per day.

I tried forcing more water through the intercooler; this helped matters as far as cooling the air to a lower temperature was concerned, but did not give us enough air to help us keep up the pressure we wanted. We were just about to do what many others have done when they found they were short of air, that is, buy another compressor, when the writer decided to build an intercooler, with the view

of removing the water from the air before it reached the high-pressure cylinder.

We never got any water from the old intercooler; but when we got the new one in operation there was a constant stream of water running from it and our air troubles were over. We could carry 100 lb. pressure, had air enough to operate our entire equipment, even after we reduced the speed of the compressor from 160 r.p.m to 130 r.p.m., removed the 150-hp. motor ant put in an old type 75-hp. L frame General Electric motor which our tests showed was developing about 85-hp.

We were about 5 months on this pipe line and never stopped one minute through the day on account of air or compressor troubles.

In view of the above facts, I am forced to the conclusion that an intercooler to be efficient must not only cool the air but remove the water from the air before it enters the high-pressure cylinder of the compressor. Now, if, as Mr. Richards says, the removal of 75 per cent. of the water will only increase the volumetric efficiency of the compressor, ½ of 1 per cent. and only reduce the power required to operate the compressor 1 per cent., I would like to have him or some other compressed air expert tell me how I got the results we got at the Union Iron Works by simply removing the water.

H. E. MacCamy.

Dear Sir:—I was very glad to receive a copy of Mr. MacCamy's interesting letter and to be given an opportunity immediately to reply. Mr. MacCamy is to be regarded as a compressed air missionary—of a certain kind—in that he is doing such effective work in provoking the users of compressed air to investigate the economical possibilities.

The idiosyncrasy of Mr. MacCamy seems to be to overdo the intercooler. Now, the intercooler is not the whole thing in air compression. Years ago many air compressors were used without intercoolers, but, in spite of all his efforts, Mr. MacCamy will never see the day when intercoolers will be used without air compressors.

I decline absolutely to discuss Mr. Mac Camy's narrative of the installation of his first intercooler, and I especially repudiate his attributing to it the alleged results accomplished. I do not question the truth of the story. In fact as it stands it tells too much truth, although there is a complete absence of all precise data which could be subjected to computation or comparison. We do know in a general way that here was a compressor installation running under unimaginably bad conditions and consequently inadequate for the service required of it. The electric motor was so hopelessly bad that it had to be thrown out entirely. What other reason could there have been for throwing it out? Of course a smaller motor that would work must have been better than a larger one that would not work.

Besides the motor, the air compressor itself was in such a bad condition, he tells us, that in running it two cylinder heads had been knocked out. Now, what had the presence or absence of an intercooler, good or bad, to do with that, or how could any intercooler have a retroactive effect, baleful or beneficient, upon what might be going on in the low pressure air cylinder? After the defective motor had been replaced and the compressor overhauled with the addition of a new intercooler things worked much better than before. Nevertheless it may be proper to warn Mr. MacCamy that if he ever states in his advertising reading matter that his intercooler will prevent the breaking of cylinder heads in the low pressure cylinder, I shall consider it my duty to post a public protest. Those who can be allured by argument of this style are in sore need of protection.

As to the effect of any intercooler, however perfect, upon the volumetric efficiency of a two-stage compressor, I have not much to say, and I am very content to leave that to common sense. In talking of the matter I would use the word "capacity" instead of "efficiency." The full stroke of the piston of the low pressure cylinder is followed by an inrush of air behind it which fills the entire space, and then the inlet valves close. If upon the return stroke all of this air could be expelled into the passage leading to the intercooler and then the discharge valves closed, that volume multiplied by the number of strokes per minute would be the capacity of the compressor for the same unit of time.

We all know that some of this air is not expelled or delivered, being retained in the unavoidable clearance spaces and re-expanding upon the return stroke of the piston; also there usually are more or less piston leakages

and valve leakages, so that the actual volume of air delivered is a more or less uncertain quantity, but whatever this quantity may be which passes the discharge valves and so on through the intercooler must, barring leakages, go on through the machine and be delivered into the compressed air system. An intercooler—even Mr. MacCamy's—does not create air and does not destroy air, and, as was said above, cannot have a retroactive effect upon anything that goes on in the low pressure cylinder. Any assertion of results contrary to this is absurd.

The normal function of the intercooler is to reduce the temperature of the partially compressed air delivered by the low pressure cylinder, and consequently its volume, so that the power required for the second stage of the compression will also be somewhat reduced, but the most valuable effect of the intermediate reduction of temperature is the prevention of excessively high temperature at the completion of the final compression. As Mr. MacCamy concedes that the old intercooler in his narrative could be made to cool the air with tolerable respectability, it is not worth while to go into that matter here. Air apparatus has been improved rapidly, and the intercoolers of all the builders may be expected to be more efficient than was that one of an earlier date.

The function of the intercooler in reducing the tempertaure of the air affords incidentally an opportunity for removing some—not all by any means—of the moisture carried by the air; and here, as we touch upon what seems to be the hobby of Mr. MacCamy, and what is evidently intended to be the real point of the letter to which I am attempting to reply, too few words will not suffice.

To begin with it is necessary to call attention to some incontrovertible facts. Air always carries water in the form of invisible vapor, and is always picking up water, or, as we say, absorbing moisture, when in contact with water or wet things. This it does up to a certain point when it promptly ceases to take any more, and then it is said to be saturated or to have a humidity of 100 per cent. This saturation point varies constantly with every slight change of pressure or of temperature. As the pressure of the air increases or, what is the same thing, its volume decreases, its capacity for moisture decreases in about the same proportion, but whatever the pressure or relative volume, an increase of temperature increases the water carrying capacity of the air very rapidly. For each rise of temperature of 20 degrees F. the moisture capacity of air is doubled, and of course, it is similarly reduced by similar fall of temperature.

Only one other thing, it is necessary for us to remember as we go along. If the humidity of the air be anywhere below 100 per cent. it will not give up the moisture it carries or will not wet things by contact so that water may accumulate and be drawn off. This we know too well by our personal experiences in the summer time when the humidity may be 80 per cent. or more, and when we suffer great discomfort for which no one has devised a remedy. Immediately, however, that the 100 per cent. limit is passed, say by the cooling of the air, all the water in excess of the 100 per cent. is ready to be given up at once, which gives the mechanical separator its opportunity.

We may suppose an air compressor to be in full operation with the air entering the low pressure cylinder with a humidity of 60 per cent., at a temperature of 60 degrees F. and being compressed and passed on to the intercooler at a pressure of 25 lb. gage. The volume of the air, under adiabatic compression, will be almost exactly one-half, and the relative humidity we might say has thus been raised to about 120 per cent.; but at the same time the temperature of the air has been raised from 60 degrees to considerably above 200 degrees, or the moisture capacity of the air has been doubled seven or eight times, and its per centage of humidity, with all the original moisture still in the air, becomes less than 10 per cent., very dry air indeed, as it enters the intercooler.

It is all very well for the intercooler to be posing before the public as a highly efficient water separator, and I am not refusing to believe what it may actually be doing in that line, nor am I by any means belittling the desirability of getting as much water as possible out of the air at this stage; but I would like to call attention to the lively work which the intercooler has to do. It will appear that the whole intercooler cannot by any means be made to act as a water separator, but only a little of the latter portion of it, because the air has to be cooled from above 200 degrees to below 100 degrees before it will begin to give up its water at all.

We thus see the importance, if any water separating is to be done at this stage, of having the intercooling as efficient as possible, since it is only the last few degrees of the cooling that bring the air to the supersaturation point. A much better arrangement in any case would seem to be to have an intercooler doing only the intercooling and then to pass the air through an efficient separator as a distinct unit and taking all the air necessarily at its lowest temperature.

The air after passing the best possible intercooler and separator and then being compressed to its final pressure in the high pressure cylinder will be discharged from the latter, the same as from the low pressure cylinder, in the condition of extremely dry air, on account of its high temperature, but with an aftercooler and another separator, or with a pipe line of sufficient length to give the air a chance to get entirely cool again, the water will again be in evidence. It is only when the air is at its highest pressure and its lowest temperature that it can be so drained of water as to cause no possible subsequent trouble, and neither of these conditions occur in any intercooler.

I regret very much that I have felt compelled to use so many words in the case. I hope that Mr. MacCamy will next time give me complete and precise data to work on.

FRANK RICHARDS.

NEW BOOK

How to Run an Automobile. By Victor W. Page. Norman W. Henley Publishing Co., New York. 178 pages, 5 by 7½ in. 72 illustrations. Price $1.00.

This book is by an engineering writer of large experience who has made the automobile his special study. It deals with all the well known automobiles in general and in detail, giving explicit instructions for starting and running. All the problems are given their solution both for regular running and for the derangements and accidents which are sure to occur. There are four chapters as follows: Automobile parts and their functions, General starting and driving instructions, Typical 1917 control system, Care of automobiles. The illustrations are exceptionally intelligible and greatly assist the text, which also is clear and simple.

NOTES

In the seventeen years from 1898 to 1915 the consumption of artificial gas from by-product coke ovens and from coal, oil and water gas plants increased more than fivefold. Very significant is the increasing use of artificial use for illumination. The by-product coke gas for fuel, and, since 1908, its decreasing use for illumination. The by-product coke oven saves the gas; the old beehive coke oven wastes it on the atmosphere.—*United States Geological Survey.*

A graphic chart published by Lord & Thomas, Chicago, shows the resources of the United States are:

World's Area	7%
World's Population	6%
World's Corn	75%
World's Cotton	66%
World's Petroleum	66%
World's Copper	50%
World's Iron	40%
World's Coal	40%
World's Manufactures	30%
World's Wheat	25%
World's Railways	40%
World's Banking Power	35%
World's Wealth	30%

To stop leakage through concrete, such as tunnel walls, clean the walls thoroughly, and paint with a solution consisting of 8¾ lb. of zinc sulphate dissolved in a gallon of water. The zinc sulphate will act on the lime in the cement, forming insoluble calcium sulphate and zinc hydroxide, which fills up the pores in the concrete. Another method is to use one part water glass (sodium silicate) to five parts of water and apply a coat with a brush. Let it dry about six hours and apply another coat. Repeat until four coats have been applied, not allowing over 20 hr. between coats.

George A. Burrell, formerly in charge of natural gasoline resources, Bureau of Mines, asserts that 40,000,000,000 cubic feet of gas will be treated for gasoline extraction in 1917 as against 24,000,000,000 cubic feet in 1916. Mr. Burrell states that the gas, before the extraction, usually burns incompletely and leaves soot in the ordinary gas burner or

stove. Removing the gasoline remedies this condition and the heavier soot-forming ingredients are converted into gasoline. The larger part of this gas will finally be used in towns and cities and will represent gas, that if it were not for the gasoline extraction, would never reach the consumer.

Most modern magnets for magneto ignition apparatus contain from 5 to 6 per cent. of tungsten, and from 0.5 to 0.7 per cent. of carbon. The heat treatment of magnet steel is totally different from that of high-speed steel. The temperatures must not be so high, or the permanence will be affected.

An interesting feature of the emergency hospital of the American Steel & Wire Company, at Fairfield, Ala., is that the office of the safety inspector adjoins that of the surgeon in charge. When an accident case is brought in, the safety inspector makes an investigation of the cause of the injury at the same time the surgeon is preparing to take care of it.

Suitable solders for any purpose can be made by judicious mixing of several constituents with lead and tin. For use in working at low temperatures, a low m.p. solder can be made by adding bismuth. A mixture of two parts of bismuth and one each of lead and tin melts at about 93 deg. Cent. (200 F.), while by the addition of mercury or alkaline metals, solders fluid at ordinary temperatures can be made. On the other hand, joints to withstand high temperatures can be made with brass, which requires the use of the blowpipe—hard soldering. In selecting a solder with respect to the temperature which the united metals can withstand, it should be borne in mind that the closer the melting points of solder and metals are together the better will be the joint.

Six clothing disinfectors of a new portable type have been purchased for the use of the U. S. army, says the *Army and Navy Journal*. The contrivance is the invention of a New York doctor. Each disinfector is capable of handling fifty uniforms and kits in forty minutes, or more than the equivalent equipment of two regiments in a day. The outfit includes a five horsepower upright steam boiler connected by piping with an air-tight chamber 6 ft. long and about 34 in. wide. The rear end of the chamber is provided with a heavy door which can be hermetically sealed. A rack for clothing slides into the chamber, while smaller articles are laid on a grating. The process includes the use of either dry steam or formaldehyde and ammonia. The mobility of the outfit is its distinguishing feature.

Cork fabric is a recent French production, the result of a new process. It is waterproof, a non-conductor of heat, and unbreakable. By using a special machine, thin slices of cork of an even thickness are obtained from a block of cork. The slices are placed in chemical baths in order to remove the resinous parts, which make cork more or less brittle substance. Upon their removal the cork sheets become flexible, and may be compared in this respect with thin leather. In fact, the sheets can be folded and bent without breaking. By combining the cork sheets with any suitable cloth, preferably a thin and strong cloth of good colour, an excellent waterproof material is obtained. An adhesive preparation is employed to glue the cork to the cloth; or if a stronger garment is desired, the cork sheets are placed between two layers of cloth.

Trinitrotoluol and picric acid explosives can be manufactured at a cost about 40% less than nitroglycerine. From this circumstance J. R. Mardick, writing in *Metallurgical and Chemical Engineering*, points out the probability that the manufacturers of these nitro-aromatic explosives will dominate the market for blasting compounds after the war. This would cheapen mining operations. The enormous increase in by-product coking since 1914 renders this assumption highly probable, since the raw materials for 'T.N.T.' and picric acid are derived from that process.

Hard clay in the heading of a 6 1-2-ft. sewer tunnel in Milwaukee was excavated by a chisel shaped cutter operated in a pneumatic hammer and pushed against the vertical face so as to remove long strips of clay, much as cut steel can be curled off the edge of a plate by an expert chipping machinist. By this method the efficiency of the workmen was increased about 140 per cent. over that when the excavation was made with pick and mattock.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 3

1,221,022. METHOD OF EVAPORATING AQUEOUS SOLUTIONS. Raymond U. Bunkre, Yonkers, N. Y.

1,221,069-70. LIQUID-ELEVATING APPARATUS. Felix J. McGuane, Chicago, Ill.

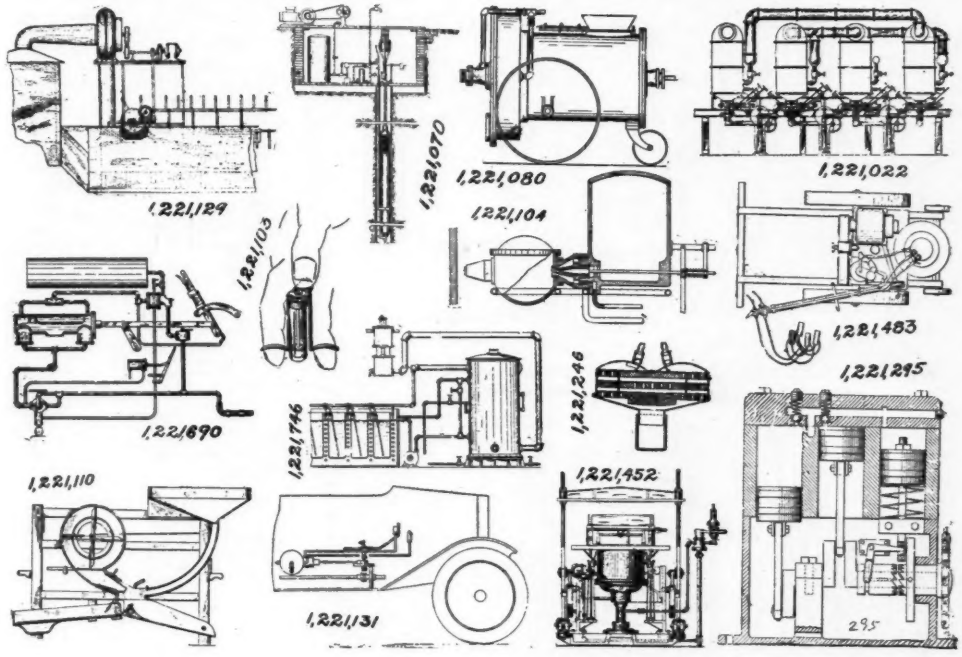
1,221,070. GRAIN-SEPARATOR. Charles Argyle Torrence, Regina, Saskatchewan, Canada.

1,221,129. DRYING APPARATUS. Charles H. Benedict, Chicago, Ill.

1,221,131. AIR-COMPRESSOR. William F. Blanchet, Tampa, Fla.

1,221,162. PNEUMATICALLY - OPERATED MUSICAL INSTRUMENT. John P. Eustis, Newton, and Albert T. Brown, Arlington, Mass.

1,221,170. PRESSURE - FOUNTAIN PAINT-BRUSH. Stanley Gasparaitis, Chicago, Ill.



PNEUMATIC PATENTS APRIL 3.

1. In a device of the class described, a fluid-pressure-actuated liquid-ejecting means, embodying a liquid outlet conduit and a fluid pressure inlet conduit; a pressure storage tank in communication with the outlet conduit; an expansible element responsive to a diminution of pressure in the tank; a valve in the inlet conduit; an operative connection between the expansible element and the valve for opening the valve; and a cut-off device in the outlet conduit, the cut-off device being manipulable to permit the passage of liquid through the outlet conduit and to effect a diminution of pressure in the tank.

1,221,079. AIR-BRAKE FOR LOCOMOTIVE-CRANES. Benjamin Mullin, Jersey City, N. J.

1,221,080. PNEUMATIC CONVEYER. John D. Murray, San Francisco, Cal.

1,221,103. VACUUM SUCTION DEVICE. John Sorensen, Brooklyn, N. Y.

1,221,104. PROCESS FOR MAKING COATINGS OF FUSIBLE SUBSTANCES. Georg Stolle, Berlin-Schoneberg, Germany.

1. The process for coating an object with a fusible coating, which comprises volatizing a coating material and projecting said volatilized coating material against the surface of the object by means of a compressed inert gas.

1,221,110. GRAIN-SEPARATOR. Charles Argyle Torrence, Regina, Saskatchewan, Canada.

1,221,129. DRYING APPARATUS. Charles H. Benedict, Chicago, Ill.

1,221,131. AIR-COMPRESSOR. William F. Blanchet, Tampa, Fla.

1,221,162. PNEUMATICALLY - OPERATED MUSICAL INSTRUMENT. John P. Eustis, Newton, and Albert T. Brown, Arlington, Mass.

1,221,170. PRESSURE - FOUNTAIN PAINT-BRUSH. Stanley Gasparaitis, Chicago, Ill.

1,221,240. AIR - LINE - PIPE CONNECTION. Lewis Steidle, Mauch Chunk, Pa.

1,221,246. RESPIRATOR. Carl Travers, Frankenholz, near Mittelbexbach, Germany.

1,221,295. AUTOMATIC AIR-PUMP. George W. Dopkins, Morris, Minn.

1,121,321. MEANS FOR BLOWING ICE-CREAM FROM MOLDS. Lionel Manuel Hender, Baltimore, Md.

1,221,328. AIR HEATER AND DRIER. Henry B. Hudepohl, Mount Healthy, Ohio.

1,221,452. MOLDING-MACHINE. John Louis Johnson, Chicago, Ill.

1,221,483. MILKING-MACHINE. David Townsend Sharples and Lawrence P. Sharples, West Chester, Pa.

1,221,495. PNEUMATIC HAND CONTROL FOR TALKING-MACHINES. Clinton E. Woods, Bridgeport, Conn.

1,221,496. LEAK-OBTURATING DEVICE FOR SHIPS. Frederic Wullyamoz and Gustave Meyer, Lausanne, Switzerland.

1. A leak stopper having a pneumatic frame, an obturating curtain carried by said frame and adapted to be placed against a surface to be repaired, and braces for said curtain and frame.

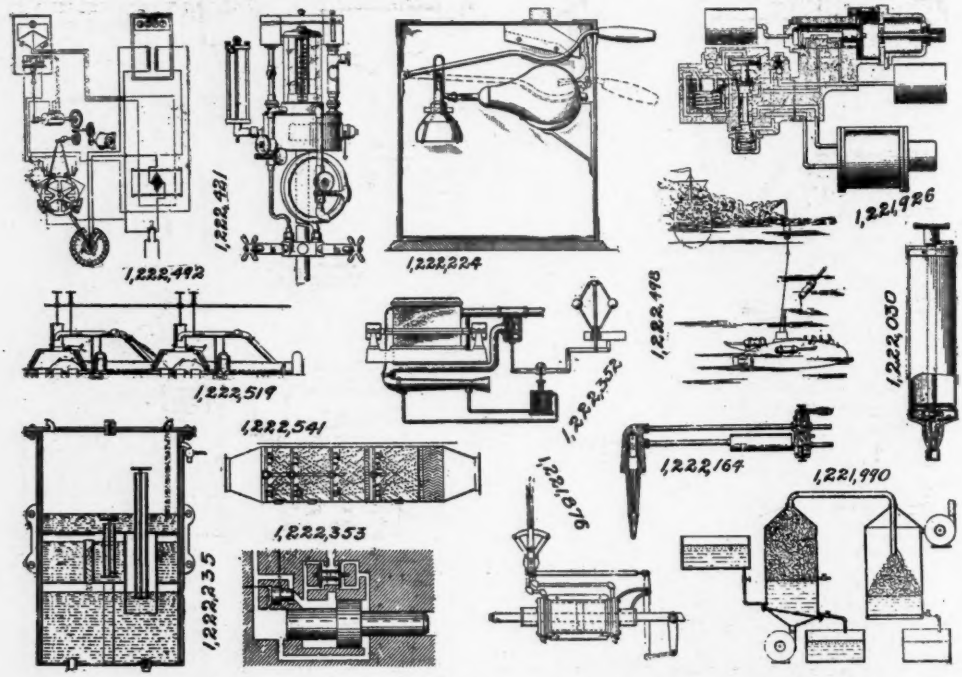
1,221,637. AIR SYSTEM FOR FORCING LIQUIDS. Charles A. Waltz, Bouseville, Pa.

1,221,676. PNEUMATICALLY - OPERATED CAM-CONTROLLER. Frank E. Case, Schenectady, N. Y.

1,221,690. SAFETY DEVICE FOR RAILWAYS. John S. Crawford, New London, Conn.

1,221,746. APPARATUS FOR MANUFACTURING ICE. Willis B. Kirkpatrick, Baltimore, Md.

1. In an apparatus for making can ice by the air agitation method, a brine tank, ice cans in the brine, drop pipes near the centers of the cans, air headers leading to the drop pipes, means for supplying air under pressure, means for cooling the brine, a dehydrater consisting of a coil submerged in water and having connections to the brine tank, means for circulating the brine through the coil and passing the air in finely divided particles through the water surrounding the coil, and means for reducing the pressure of the air as it enters the cans.



PNEUMATIC PATENTS APRIL 10.

APRIL 10

1,221,826-7. SAFETY DEVICE FOR RAILROADS. Clayton A. Brooks, Girard, Pa.

1,221,876. FLUID - PRESSURE - OPERATED VALVE - GEAR - SHIFTING MECHANISM. Samuel H. Lewis, Richmond, Va.

1,221,924. INDICATING SYSTEM FOR PNEUMATIC CONVEYORS. Albert F. Thompson and Henry T. Free, Kansas City, Mo.

1,221,926. BOOSTER - VALVE FOR AIR-BRAKES. Walter V. Turner, Edgewood, Pa.

1,221,990. PROCESS OF OBTAINING STARCH. Hiram C. Holden, Pittsburgh, Pa.

3. The process of separating impurities such as gluten and fibrous material from starch liquor which consists in passing a multiplicity of fine streams of air into the starch liquor under pressure, thereby causing a voluminous froth and entangling said impurities therein, applying suction to the froth to remove the same from the starch liquor, and collecting said froth in a receptacle apart from the starch liquor.

1,222,030. AIR-PUMP FOR GASOLINE-TANKS. George E. Raymond, Los Angeles, Cal.

1,222,084. BURNER. Charles Donaldson, Brookville, Pa.

1,222,164. CONTROLLING - VALVE FOR ACETYLENE CUTTING AND WELDING TORCHES. Walter W. von Todenwarth, Rahway, N. J.

1,222,224. PERFUME-VENDING MACHINE. John F. McNeil, Phoenix, Ariz.

1,222,235. FUEL - FEEDING DEVICE FOR AUTOMOBILES. William H. Muzzy, Detroit, Mich.

1,222,321. VALVE FOR COMPRESSORS AND PUMPS. Arthur E. Peters, Easton, Pa.

1,222,352. REGULATING MECHANISM FOR CENTRIFUGAL COMPRESSORS AND PUMPS. Otto Banner, Easton, Pa.

1,222,353. VALVE FOR PERCUSSIVE TOOLS. Lewis C. Bayles, Easton, Pa.

1,222,410. COMPRESSED-AIR SHUTTLE-OPERATING MECHANISM FOR LOOMS. Harry H. Kelley, Atlanta, Ga.

1,222,421. APPARATUS FOR ADMINISTERING ANESTHETICS. David Lambert, New York, N. Y.

1,222,454. PNEUMATIC CARPET-CLEANER. Edwin E. Overholt, Washington, D. C.

1,222,477. VACUUM-CLEANER. John W. Shanahan and Francis C. Mason, Grand Rapids, Mich.

1,222,492. FLUID-METER. Carl Clapp Thomas, Madison, Wis.

1,222,498. SUBMARINE WARFARE. Joseph A. Steinmetz, Philadelphia, Pa.

2. The combination with a submarine, of a gas tank secured upon the exterior of the submarine and adapted to hold a large supply of incapacitating gas, and means controlled by those within the submarine for allowing said gas to pass rapidly into the free air above the submerged submarine.

1,222,519. AIR-CONTROL SYSTEM FOR FURNACES. William H. Bradley, Pittsburgh, Pa.

1,222,520. PNEUMATIC - TIRE INFLATER. Matt Buzzard, Fenton, Mich.

An acetylene gas generator comprising a pair of vessels, a partition between said vessels, gas discharge means for one of the vessels, a tube extending through the other vessel and the partition and detachable from the latter to permit the flow of water from said vessel to the other

1,222,541. COMPRESSED-AIR WASHER. Benjamin C. Donham, Glen Ridge, N. J.

1. An air washer comprising a conduit for the air, and means to pass liquid in different conditions of fineness of sub-division into said air, and including means to effect atomization of the liquid, but retaining it in a condition of free moisture, whereby foreign particles may be precipitated by such free moisture.

1,222,554. VENTILATOR. Herman H. Lind, Lakewood, Ohio.

1,222,569. VENTILATING SYSTEM FOR TUNNELS AND THE LIKE. Denton K. Swartwout, Cleveland, Ohio.

1. In a ventilating system for tunnels, the combination of a movable partition that is adapted to separate the tunnel into two compartments, and a forced-draft apparatus arranged to suck air out of one of the compartments and exhaust it into the other.

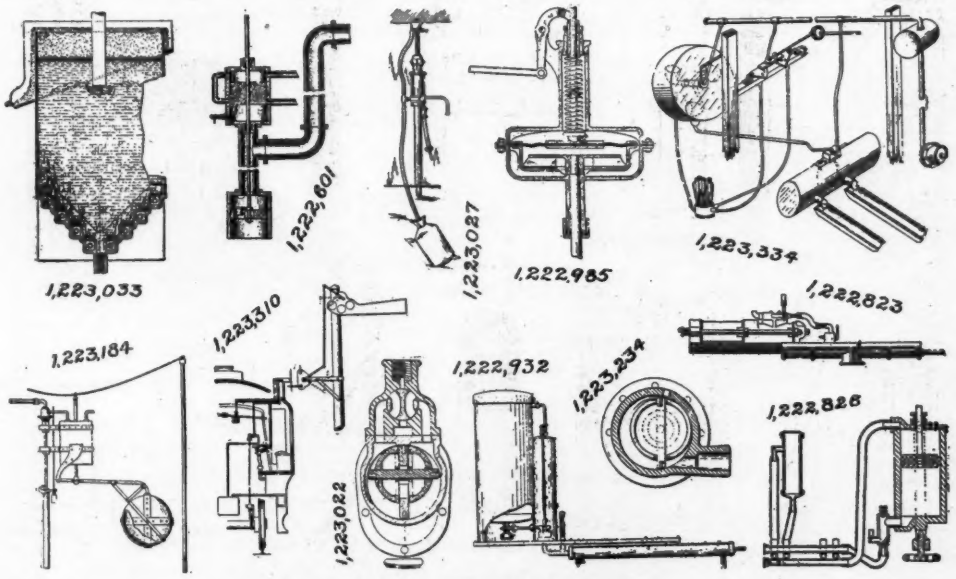
APRIL 17

1,222,601. APPARATUS FOR PUMPING FLUID. Osmon B. Campbell, Jr., St. Joseph, Mo.

1. In a liquid pumping apparatus, a liquid conduit having a valved inlet near its lower end, a liquid pump, and an engine of the internal combustion, two-cycle type, in such operative relation that an explosion occurring in the combustion chamber of the engine will impart upward motion and impetus to liquid in the conduit, and that gases passed to the combustion chamber of the engine will be compressed therein by the descent of liquid through the liquid conduit into the liquid pump.

1,222,758. VALVE FOR PIPES FOR THE CONDUCTION OF LIQUID AND GASEOUS FLUIDS. George C. Hall and Alfred Bradshaw, Calgary, Alberta, Canada.

1,222,823. PNEUMATIC DRILL. James C. H. Vaught, New York, N. Y.



PNEUMATIC PATENTS APRIL 17.

1,222,826. MILKING-MACHINE APPARATUS. John Wilfred Llewellyn Warren, Auckland, New Zealand.

1,222,932. STERILIZING APPARATUS. Leon Chevalle, Sardis, British Columbia, Canada.

1. In a sterilizing apparatus of the class described, the combination with a container provided with an outlet faucet in its lower portion and an inlet passageway in its upper portion, of a tank containing compressed sterilized air; a valve-controlled pipe connecting the interior of said tank with said inlet passageway; and mechanism operatively disposed to connect the valve-cock of the valve of said valve-controlled pipe with the valve-cock of said faucet and adapted to be manually operated first to admit said sterilized air into said container and thereafter to open the passageway through said faucet.

1,222,984-5. PRESSURE-OPERATED APPARATUS. Gordon C. Pharo, Marysville, Cal.

1,223,022. PNEUMATIC DRILL. Archie M. Baird, Topeka, Kans.

1,223,027. DUST-COLLECTOR FOR ROCK-DRILLS. George C. Brackett, Denver, Colo.

1,223,033. APPARATUS FOR SEPARATING OR CONCENTRATING ORES. David Cole, Morenci, Ariz.

1. In a frothing classifier, a tank, and a porous medium through which air is admitted to said tank, said porous medium being ar-

ranged with different portions thereof at different levels and being of different thicknesses at the several levels respectively.

1,223,048. PNEUMATICALLY-PLAYED MUSICAL INSTRUMENT. Gustav Karl Hennig, Bohlitz-Ehrenberg, near Leipzig, Germany.

1,223,184. WAVE-MOTOR. August Victor Larson, Bridgeport, Conn.

1. A wave motor including a standard, a post adjustably mounted therein, a compressor cylinder carried by said post, a float, an arm carried by said float pivotally supported by said cylinder, and means for locking said post in adjusted position.

1,223,234. PNEUMATIC TEST-HOLE DRILL. Archie M. Baird, Topeka, Kans.

1,223,265. PNEUMATIC ACTION FOR PLAYER-PIANOS. Judson Rogers De Noyelles, Binghamton, N. Y.

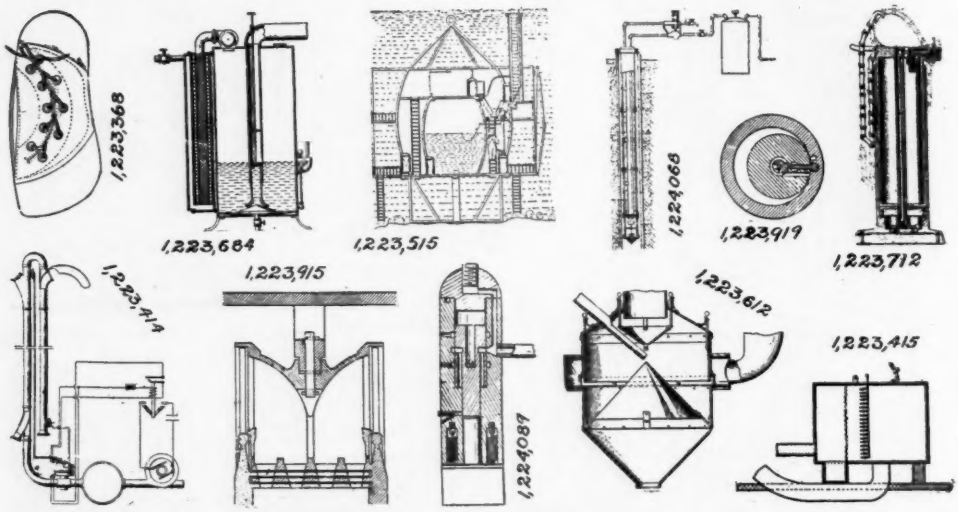
1,223,310. AUTOMATIC TRAIN-STOP. Ephraim Chabot, Providence, R. I.

particles of material collected therein, and means permitting vertical adjustment of said deflector plate.

1,223,682. PUMP OR COMPRESSOR FOR MOTOR-VEHICLES AND THE LIKE. Alfred H. Fefelle, Buffalo, N. Y.

1,223,684. VENTILATION AND CLEANING DEVICE. John C. Fleming, Boston, Mass.

2. An improved method of ventilation and cleaning air comprising guiding a stream of atmospheric air at atmospheric pressure to the bottom of a purifying liquid, maintaining a rarefaction of air above the surface of said liquid, thereby causing said air at atmospheric pressure to pass downwardly into the liquid and then to be discharged upwardly therefrom by its natural force, whereby the air is rarefied and cooled, neutralizing any impure gases intermingled with the air, and finally delivering the purified air to the space to be ventilated.



PNEUMATIC PATENTS APRIL 24.

1,223,334. MILKING-MACHINE. Johan Wielaert, Remuera, Auckland, New Zealand.

APRIL 24

1,223,368. PNEUMATIC ARCH - SUPPORT. Rose Schuessler Carling, Los Angeles, Cal.

1,223,407. RIVETING-TOOL. Walter Leon Lindsay, Chicago, Ill.

1,223,414. PNEUMATIC - DESPATCH - TUBE APPARATUS. John T. Needham, New York, N. Y.

1,223,415. BOLL - WEEVIL - DESTROYING MACHINE. James H. Nolin, New Brockton, Ala.

1,223,515. DIVING APPARATUS. Athanasios Papanastasiou, East Pittsbrugh, Pa.

1,223,586. CEMENT-GUN APPARATUS. John F. Johnson, Pittsburgh, Pa.

1,223,612. SEPARATOR FOR GRINDING-MILLS. William J. Price, Dixon, Ill.

5. A separator for use in connection with grinding mills, said separator comprising a casing having pneumatic separating means therein, the lower end of said casing having a coarse material outlet while a fine material discharge pipe extends from the upper end of said casing, a funnel-shaped deflector plate disposed beneath and of greater diameter than said pipe, said plate having a central opening to discharge comparatively large

1,223,712. FLUID-PRESSURE LIFTING-JACK. John Max Meyers, West Chester, Pa.

1,223,758. PNEUMATIC MOTOR. George P. Brand, New York, N. Y.

1,223,885. AUTOMATIC REGULATOR FOR PNEUMATIC PIANOS. Vern L. Jones, Detroit, Mich.

1,223,915. ELASTIC-FLUID TURBINE. Oscar Anton Wiberg, Finspong, Sweden.

1,223,919. ROTARY PUMP. Walter J. Wilson, Petersburg, Ind.

1,224,068. PNEUMATIC WATER-LIFT. John G. Chason, Colquitt, Ga.

2. In a device of the class described, a water outlet pipe, an air inlet pipe, a cylinder connected to the outlet pipe, a piston operable in said cylinder, a pistod rod extending upwardly from said piston, a cross head carried by the piston rod, arms extending downwardly from said rod, a weight supported by the lower ends of the arms, a normally closed valve in the inlet pipe, and a stem positioned above said valve and beneath the weight for engagement with said valve when the weight descends, the said piston lowering under the influence of the weight when the pressure in the cylinder becomes reduced.

1,224,089. PNEUMATIC SCALING-TOOL. Elmer A. Hawley, Des Moines, Iowa.